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The American Archaeology Division
Department of Anthropology, University of Missouri
Columbia, Missouri

Prehistoric Cultural Continuity in the Missouri Ozarks: The Truman Reservoir Mitigation Project

Volume II — Artifact Descriptions and Analyses

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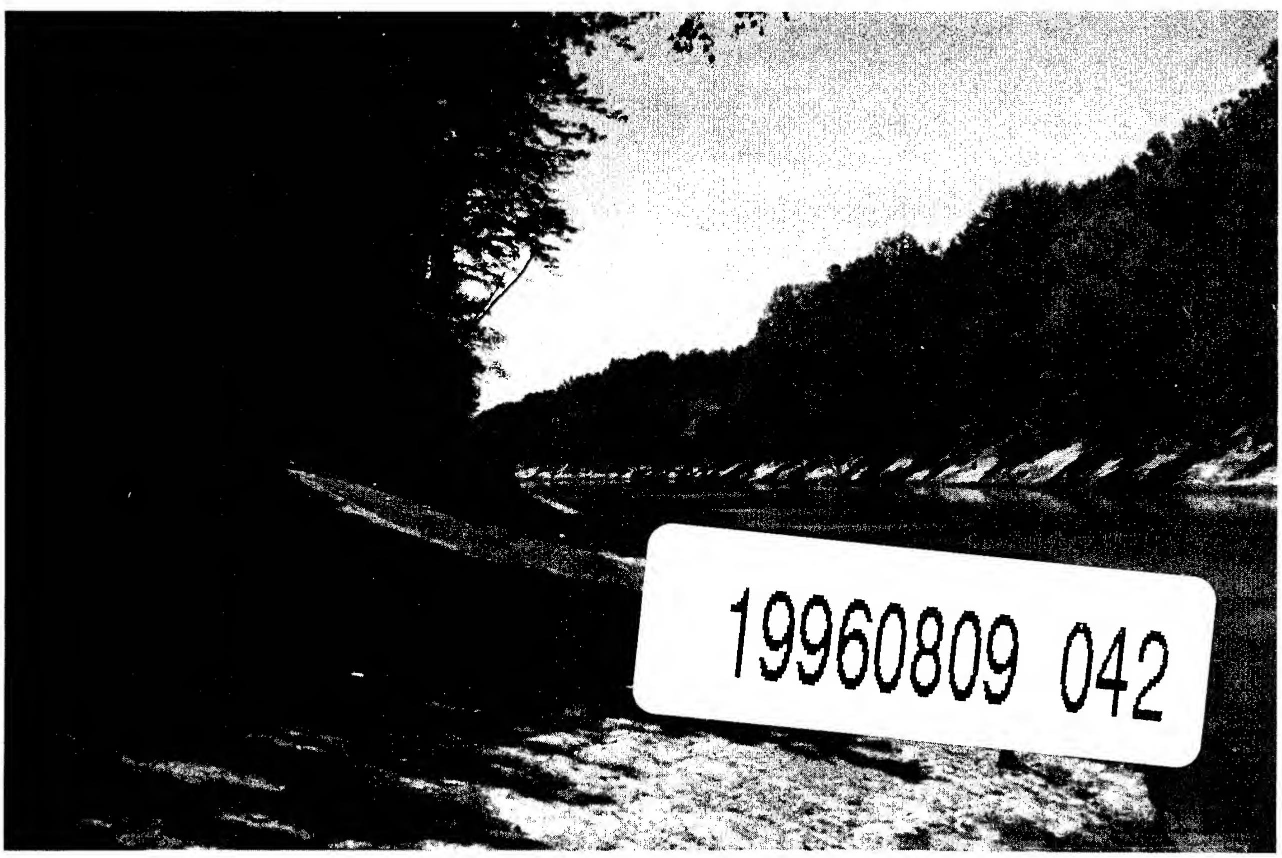

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By: Donna C. Roper
Principal Investigator

PREHISTORIC CULTURAL CONTINUITY IN THE MISSOURI OZARKS: THE TRUMAN RESERVOIR MITIGATION PROJECT

VOLUME II:

ARTIFACT DESCRIPTIONS AND ANALYSES

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The American Archaeology Division
Department of Anthropology
University of Missouri
Columbia, Missouri

Donna C. Roper, Principal Investigator

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ARTIFACT DESCRIPTIONS AND ANALYSES

TABLE OF CONTENTS

	Page
LIST OF FIGURES	xi
LIST OF TABLES	xv
LIST OF PLATES	xix
PART I. PROJECTILE POINTS by Susan K. Goldberg and Donna C. Roper	1
INTRODUCTION	3
PROCEDURES AND DEFINITIONS	4
Formation of Classes	4
Measurements and Observations	5
THE COLLECTIONS	10
Lanceolate Points	10
Side-Notched Points	15
Basal-Notched Points	33
Straight-Stemmed Points	37
Contracting Stem Points	45
Corner-Notched Points	52
Arrows	71
REFERENCES CITED	78
PART II. CERAMICS by V. Ann Tippitt	99
PART III. HEMATITE by Donna C. Roper and Margaret A. Van Ness	109
INTRODUCTION	111
HEMATITE AS A MINERAL	111
SOURCES OF HEMATITE	112
ANALYSIS PROCEDURES AND CATEGORY DEFINITIONS	115

VOLUME II

TABLE OF CONTENTS: Continued

	Page
PART III. HEMATITE - Continued	
DESCRIPTION OF THE COLLECTIONS	117
Tools	117
Worked Hematite	119
Unmodified hematite	121
RAW MATERIAL SELECTION	121
SPATIAL AND TEMPORAL DISTRIBUTIONS	123
THE USES OF HEMATITE IN THE WESTERN MISSOURI OZARKS - SYNTHESIS AND COMPARISONS	128
SUMMARY AND CONCLUSIONS	129
REFERENCES CITED	131
PART IV. LITHICS STUDIES	135
NUMBER 1. LITHIC LABORATORY PROCEDURES MANUAL	135
OVERVIEW OF THE ANALYSIS	136
PROCEDURE	138
General Instructions	138
Raw Material	139
The Analysis of Flakes	146
The Analysis of Tools	162
Comments	169
Procedure for Picking Up Collections	170
NUMBER 2. A STUDY OF CHERT RESOURCES IN THE TRUMAN RESERVOIR: AVAILABILITY, PROCUREMENT, AND UTILIZATION by Jack H. Ray	171
ACKNOWLEDGEMENTS	172
ABSTRACT	173
INTRODUCTION	175
LITERATURE REVIEW	178

VOLUME II

TABLE OF CONTENTS: Continued

Page

PART IV. NUMBER 2 - Continued

GEOLOGICAL SETTING 182

The Nature and Genesis of Chert 187
Truman Reservoir Cherts 188
Cherts Surrounding Truman Reservoir 191

CHERT AVAILABILITY AND PROCUREMENT 198

Natural Chert Sources 201
Cultural Chert Source 204
Modes of Procurement 204
Local vs Non-Local and Exotic Procurement and Depositional Patterns 205
Economizing Hypothesis 206
Factors Affecting Procurement 206

1979 CHERT SURVEY 208

Chert Survey Strategy 208
Chert Site Survey Form 209
Field Equipment 212
Survey Procedure 212
Sampling Method 215
Archeological Sites 216
Chert Percentage Predictions 217
Analysis 217

CHERT RESOURCE TERRITORY STUDIES 219

23BE337 220
23HI297 231
23SR189 246
23HE9 252
23SR400 261
23SR653 269
23BE660 276
23BE676 279
23BE681 283
23SR504-23SR675 286
23BT27 Artifactual Analysis 290

SUMMARY AND CONCLUSIONS 291

APPENDIX A: STREAM DEPOSITED CHERT TEST 294

REFERENCES CITED 305

PLATES 313

VOLUME II

TABLE OF CONTENTS: Continued

	Page
PART IV. LITHICS STUDIES	
NUMBER 3. REPLICATING CHIPPED STONE TOOL ASSEMBLAGES FROM THE TRUMAN RESERVOIR by Jack H. Ray	321
ABSTRACT	322
INTRODUCTION	323
PURPOSE	323
TOOL KIT	324
RAW MATERIALS	325
PROCUREMENT	326
FLINT KNAPPING TECHNIQUES	327
FLINT KNAPPING PROCEDURE	328
APPENDIX	332
REFERENCES CITED	334
NUMBER 4. THE EFFECTS OF HEAT TREATMENT ON CHERTS FROM THE TRUMAN RESERVOIR by Jack H. Ray	341
ABSTRACT	342
ACKNOWLEDGEMENTS	343
INTRODUCTION	344
PROCUREMENT	345
NATURE OF CHERT	346
HEAT TREATMENT EXPERIMENTS	346
Muffle Oven	347
First Aboriginal Heat Treatment Experiment	348
Second Aboriginal Heat Treatment Experiment	349
PHYSICAL PROPERTY TESTS	353
Resiliency	354
Hardness	355

VOLUME II

TABLE OF CONTENTS: Continued

	Page
PART IV. NUMBER 4 - Continued	
CONCLUSIONS	359
REFERENCES CITED	361
NUMBER 5. A STUDY OF THE EFFICACY OF USE-WEAR ANALYSIS AS A DESCRIPTIVE DEVICE FOR USE WITH THE H. S. TRUMAN RESERVOIR ARCHEOLOGICAL PROJECT ARTIFACT COLLECTIONS by Pamela J. Briney-Bugbee	365
ACKNOWLEDGEMENTS	366
INTRODUCTION	367
THE COMPREHENSIVE EXPERIMENTS	372
Macro-wear Analysis	373
Micro-wear Analysis	374
Lack of Synthesis	375
The Limitations of Use-Wear Analysis	379
Distinguishing Use-Wear from Non-Use Related Damage	383
Confidence Levels for Use-Wear Analysis	385
THE MODEL	388
Mode of Action	388
Worked Materials	392
Variation in Use-Wear Indicators	392
Additions to the Model	393
TECHNIQUES EMPLOYED	395
METHODOLOGY	395
The Tool Kit	396
Recording Procedures Prior to Use	396
Recording Procedures During Use	398
Procedure for Designating Used Areas of the Tool	398
Recording Procedures After Use	401
Experimental Controls	403
THE EXPERIMENTS	405
The First Experimental Series	406
The "Blind Test"	406
Paper Bag "Wear" Experiment	407

VOLUME II

TABLE OF CONTENTS: Continued

	Page
PART IV. NUMBER 5 - Continued	
THE RESULTS OF THE FIRST EXPERIMENTAL SERIES	408
Discussion of Use-Wear Damage Indicative of Mode of Action	431
Use-Wear Evidence Observed for Multipurpose Tools	449
Discussion of Relative Hardness Indicators vs. Use-Wear Damage Observed	451
Discussion of Model Polishes vs Observed Polishes as an Indicator of Material Processed	456
Discussion of the Chert Type Variable	461
Discussion of the Tool Form Variable	465
Discussion of the Impact of Incidental Damage on Observed Use-Wear Traces	469
DISCUSSION OF "PAPER BAG" POLISH	471
RESULTS OF THE "BLIND TEST" EXPERIMENT	473
Overall Results	478
"Use-Wear" Evidence on Unused Tools	479
Partially Correct Identifications	481
SUMMARY AND CONCLUSIONS	485
REFERENCES	490
NUMBER 6. AN ANALYSIS OF EIGHT LATE ARCHAIC PERIOD SITES IN THE TRUMAN PROJECT AREA by Diane L. Solov	503
AKNOWLEDGEMENTS	504
OBJECTIVES	505
THE ARCHAIC	505
THE ARCHAIC IN MISSOURI	507
THE ENVIRONMENT	510
ON THE ANALYSIS OF SURFACE SITES	513
METHODS	514

VOLUME II

TABLE OF CONTENTS: Continued

	Page
PART IV. NUMBER 6 - Continued	
THE SITE COLLECTIONS	518
23HE116	518
23HE238	522
23HE448	524
23BE183	526
23BE312	528
23BE315	530
23BE445	531
23BE448	533
CHERT RESOURCES AND UTILIZATION	535
DISCUSSION	541
CONCLUSION	544
APPENDIX: WELL MADE TOOLS AND LITHIC REDUCTION	545
REFERENCES CITED	553
PLATES	556

VOLUME II

LIST OF FIGURES

	Page
PART I. PROJECTILE POINTS	
1. Elements of a projectile point	6
2. Quantitative observations on projectile points	8
3. Qualitative observations on projectile points	9
PART III. HEMATITE	
1. Hematite occurrences in southern Missouri	113
2. Hematite sources in Benton County	114
3. SELGEM coding format for hematite	116
4. Hematite artifact key	118
PART IV. LITHICS	
NUMBER 1. LITHIC LABORATORY PROCEDURES MANUAL	
1. Chert identification key	142
2. Front and side view of flake	147
3. Orientation of tools	148
4. Flake breakage key	149
5. How to take flake measurements - a. linear, b. angular	151
6. Measurements made of flakes, blades, and flake/blades	153
7. Key for edge reduction	154
8. Key for major debris classes	157
9. Flake key	158
10. Blade key	159

VOLUME II

LIST OF FIGURES: Continued

Page

PART IV. NUMBER 1 Continued

11. Core key 160

12. Flake core key 161

13. Bifacial tool key 163

14. Key for bifacial, unifacial tools with steeply beveled edge 165

NUMBER 2. A STUDY OF CHERT RESOURCES IN THE TRUMAN RESERVOIR: AVAILABILITY, PROCUREMENT, AND UTILIZATION

1. Truman reservoir in relation to physiographic provinces 183

2. Geologic map of formation outcrops in the Truman Reservoir area 184

3. Generalized columnar section of Jefferson City, Chouteau, and Burlington chert-bearing formations which outcrop within Truman Reservoir 186

4. Geologic column of Gasconade and Roubidoux formations 192

5. Geologic column of the Mississippian System 195

6. Harry S. Truman Reservoir chert site survey form 211

7. Distribution of Chert Survey territories within Truman Reservoir 214

8. Chert survey of territory BE337 221

9. Chert survey of territory HI297 232

10. Chert survey of territory SR189 247

11. Chert survey of territory HE9 253

12. Chert survey of territory SR400 262

13. Chert survey of territory SR653 270

14. Chert survey of territory BE660 277

VOLUME II

LIST OF FIGURES: Continued

Page

PART IV. NUMBER 2 Continued

15. Chert survey of territory BE676 280

16. Chert survey of territory BE681 284

17. Chert survey of territory SR504-SR675 287

NUMBER 5. A STUDY OF THE EFFICACY OF USE-WEAR ANALYSIS AS A DESCRIPTIVE DEVICE FOR USE WITH THE H. S. TRUMAN RESERVOIR ARCHEOLOGICAL PROJECT ARTIFACT COLLECTIONS

1. Orientation of tools having bulbs of percussion 399

2. Orientation of tools without bulbs of percussion but having clearly defined distal and proximal ends 400

3. Orientation of tools without bulbs of percussion or clearly defined distal and proximal ends 402

4. Record of macrowear damage - a. before use, b. after use 432

5. Record of macrowear damage - a. before use, b. after use 433

6. Record of before use macrowear, showing scars of the size and distribution associated by Tringham et al. (1974) with cutting soft materials 435

7. Record of macrowear damage - a. before use, b. after use 436

8. Record of macrowear damage - a. before use, b. after use 438

9. Record of macrowear damage - a. before use, b. after use 439

10. Record of macrowear damage - a. before use, b. after use 440

VOLUME II

LIST OF FIGURES: Continued

PART IV. NUMBER 5 - Continued — Page

11. Record of macrowear damage - a, c, e, before use; b, d, f, after use — 442

12. Record of macrowear damage - a, c, e, before use; b, d, f, after use — 446

13. Record of macrowear damage - a, c, e, before use; b, d, f, after use — 447

14. Record of macrowear damage - a, c, e, before use; b, d, f, after use — 467

15. Record of macrowear damage - a, c, e, before use; b, d, f, after use — 468

16. Record of macrowear damage - a, c, e, before use; b, d, f, after use — 470

NUMBER 6. AN ANALYSIS OF EIGHT LATE ARCHAIC PERIOD SITES IN THE TRUMAN PROJECT AREA

1. Cultural-temporal periods in Eastern North America, the Plains, and in Missouri — 506

2. Late Archaic sites in the Truman Reservoir — 509

3. The geographical location of the Truman Reservoir area — 511

4. Soil distribution in the Truman Reservoir Project area — 512

5. Eight Late Archaic sites in the Truman Reservoir Project area — 515

6. The locations of 23HE116, 23HE238, 23HE448, and chert collection territory HE9 — 520

7. The locations of 23BE183, 23BE312, 23BE315, and chert collection territory BE337 — 527

8. The location of 23BE448 and chert collection territory BE676 — 534

VOLUME II

LIST OF TABLES

	Page
PART II. CERAMICS	
1. Survey ceramics	101
2. Ceramics from 23BE337	104
3. Ceramics from 23BE676	106
PART III. HEMATITE	
1. Descriptive attribute summaries	120
2. Hematite type by artifact type	122
3. Hardness by artifact type	122
4. Frequency of occurrence of hematite in Truman Reservoir sites	124
5. Use of hematite by periods	126
PART IV. LITHICS	
NUMBER 1. LITHIC LABORATORY PROCEDURES MANUAL	
1. Oolite key	143
2. Chert type definitions	144
NUMBER 2. A STUDY OF CHERT RESOURCES IN THE TRUMAN RESERVOIR: AVAILABILITY, PROCUREMENT, AND UTILIZATION	
1. Descriptive summary of chert types	196
2. Frost-line depth during winter months of 1967-1980	202
3. Chert quality criteria	213
4. Chert percentage predictions	218
5. Site 23BE337: Total artifact composite for squares 60S 79E, 62S 83E, 66S 83E	224
6. Site 23BE337: Chi-square comparison of components by square	225
7. Site 23BE337: Comparison of debris to collection predictions by square	229

VOLUME II

LIST OF TABLES: Continued

PART IV. LITHICS. NUMBER 2. Continued

		Page
8.	Site 23BE337: Chi-Square analysis of squares 60S 79E, 62S 83E, 66S 83E chert-artifacts	230
9.	Site 23HI297: Total artifact composite for squares 221N 92W, 221N 115W, 221N 132W	236
10.	Site 23HI297: Chi-Square comparison of components by square	238
11.	Site 23HI297: Chi-Square comparison of tools to debris by square	241
12.	Site 23HI297: Comparison of debris to collection predictions by square	243
13.	Site 23HI297: Chi-Square analysis of squares 221N 92W, 221N 115W, and 221N 132W chert-artifacts	245
14.	Site 23SR189: Total artifact composite for square 20S 85E	250
15.	Site 23SR189: Chi-Square analysis of square 20S 85E chert-artifacts	251
16.	Total artifact composite for 23HE9	257
17.	Chi-Square of tools and debris chert types at 23HE9	259
18.	Observed percentages of tools and debris by chert type and predicted percentages for 23HE9	260
19.	Total artifact composite for 23SR400	265
20.	Chi-Square analysis of 23SR400 chert-artifacts	267
21.	Chi-Square of tools and debris chert types at 23SR400	268
22.	Total artifact composite for 23SR653	274
23.	Chi-Square analysis of 23SR653 chert-artifacts	275
24.	Stream deposited chert nodule data from ten randomly selected squares	297

VOLUME II

LIST OF TABLES: Continued

Page

PART IV. LITHICS. NUMBER 2 Continued

25. Jefferson City composite table for ten test squares 299

26. Chouteau composite table for ten test squares 300

27. Burlington composite table for ten test squares 301

28. Total chert composite table for ten test squares 302

NUMBER 4. THE EFFECTS OF HEAT TREATMENT ON CHERTS FROM THE TRUMAN RESERVOIR

1. Resiliency 356

2. Hardness 358

NUMBER 5. A STUDY OF THE EFFICACY OF USE-WEAR ANALYSIS AS A DESCRIPTIVE DEVICE FOR USE WITH THE H. S. TRUMAN RESERVOIR ARCHEOLOGICAL PROJECT ARTIFACT COLLECTIONS

1. The model - modes of action 389

2. The model - relative hardness of materials 390

3. Relative hardness of materials used 394

4. First experimental series: description and results 409

5. Results of blind test 474

NUMBER 6. AN ANALYSIS OF EIGHT LATE ARCHAIC PERIOD SITES IN THE TRUMAN PROJECT AREA

1. Summary of unmodified debris, modified debris, and tools from the sample of eight Late Archaic sites 519

2. Crosstabulation of chert type by source for subgroup of sites 23HE116, 23HE238, and 23HE448 538

VOLUME II

LIST OF TABLES: Continued

Page

PART IV. NUMBER 6 Continued

3. Crosstabulation of chert type by source for subgroup of sites 23BE445, 23BE312, 23BE183, and 23BE315 540

4. Crosstabulation of chert type by source for 23BE448 542

VOLUME II

LIST OF PLATES

		Page
PART I.	PROJECTILE POINTS	
1.	Lanceolate and side-notched points	87
2.	Side-notched points	88
3.	Side-notched points	89
4.	Basal-notched and straight stem points	90
5.	Straight stem points	91
6.	Straight stem and contracting stem points	92
7.	Contracting stem points	93
8.	Corner-notched points	94
9.	Corner-notched points	95
10.	Corner-notched points	96
11.	Arrows	97
PART IV.	LITHICS	
NUMBER 2.	A STUDY OF CHERT RESOURCES IN THE TRUMAN RESERVOIR: AVAILABILITY, PROCUREMENT AND UTILIZATION	
1.	a, Stratigraphic relationship of Jefferson City (Ojc), Chouteau (Mk), and Burlington (Mo) formations separated by an unconformity (U) and Northview shale (Mn); b, The "Pierson" formation considered in the Truman Reservoir as "basal Burlington" (bMo)	313
2.	a, Lenticular bed and "free" nodules of Jefferson City chert; b, Thin bands of Jefferson City chert; c, Oolitic Jefferson City chert; d, Banded Jefferson City chert; e, Mottled Jefferson City chert	314
3.	a, Lenticular or tabular nodules of Chouteau chert; b, Characteristic blocky, poor quality Chouteau; c, Mottled and fossiliferous Chouteau chert; d, Fossiliferous Burlington chert with characteristic crinoids	315

VOLUME II

LIST OF PLATES: CONTINUED

Page

PART IV. NUMBER 2: Continued

4. a, A seam or continuous layer of Burlington chert; b, An irregular large nodule of Burlington chert 316

5. a, *In situ* bedrock chert consolidated in dolomite matrix; b, Residual chert nodules; c, Re-entrant formed by the less resistant Northview shale between the Chouteau and Burlington formations; d, Secondarily redeposited chert nodules in a stream gravel bar 317

6. a, Undulating strata within BE337; b, Chouteau-Burlington contact expressed in an anticlinal fold southwest of BE337; c, Faulting located 5 km southwest of BE337 318

7. a, Stream redeposited chert nodules at the confluence of Wolf Creek and Horse Hollow Branch: the test site; b, A 5 x 5 m grid laid out over the large gravel bar; c, Redeposited nodules in test square 9; d, Redeposited nodules in test square 16 319

NUMBER 3. REPLICATING CHIPPED STONE TOOL ASSEMBLAGES FROM THE TRUMAN RESERVOIR

1. Functional categories of replicated artifacts 336

2. Tool kit 337

3. Steps in lithic reduction 338

4. Steps in lithic reduction 339

NUMBER 4. THE EFFECTS OF HEAT TREATMENT OF CHERTS FROM THE TRUMAN RESERVOIR

1. Aboriginal heat treatment experiment 364

NUMBER 5. A STUDY OF THE EFFICACY OF USE-WEAR ANALYSIS AS A DESCRIPTIVE DEVICE FOR USE WITH THE H. S. TRUMAN RESERVOIR ARCHEOLOGICAL PROJECT ARTIFACT COLLECTIONS

1. Experimental tools 838, 531, 523, and 530 495

VOLUME II

LIST OF PLATES: Continued

Page

PART IV. NUMBER 5 - Continued

2. Experimental tools 534, 544, 548, 554 497

3. Experimental tools 554, 222, 255, 261, 269 499

4. Experimental tools 231, 234, 262 and 722 501

NUMBER 6. AN ANALYSIS OF EIGHT LATE ARCHAIC PERIOD SITES IN THE TRUMAN PROJECT AREA

1. Artifacts from 23BE183 and 23BE445 556

2. Artifacts from 23HE116 557

3. Artifacts from 23BE448 and 23HE238 558

4. Artifacts from 23BE312 and 23BE315 559

PART I.

PROJECTILE POINTS

by

Susan K. Goldberg and Donna C. Roper

ABSTRACT

The projectile points collected during the 1977-1979 field investigations are described. Chronological data are given, when possible.

PROJECTILE POINTS

by

Susan K. Goldberg and Donna C. Roper

INTRODUCTION

The definition of cultural complexes and establishment of their relative chronology in the Truman Reservoir and surrounding area has been almost totally dependent upon the study of projectile points. A variety of techniques have been used, including: (1) identification and typological cross-dating, (2) association of unknown categories of points with known groups to infer the former's affiliations, (3) association of classes of points with other datable materials such as ceramics, C-14, or TL dates, and (4) examination of stratified deposits. The Truman Reservoir Mitigation Project has used all of these techniques and in so doing has been able to better understand the basic culture history of the Osage River Basin. It is from such an understanding that the ability to work toward other project goals is derived.

A satisfactory projectile point sequence has never been available for the Truman Reservoir area. Certainly the sequence at Rodgers Shelter (Kay 1978) is long, stratified, and well-controlled. However, it is best for the portion of the prehistoric record prior to and during the Hypsithermal and is less satisfactory for the last 4000 years. It is, however, sites from this 4000 year period that comprise the major portion of the archeological record in the remainder of the reservoir. Chapman (1954) and Wood (1961) both were faced with a large mass of unidentifiable specimens from the Pomme de Terre Reservoir surveys. They responded by formulating a series of descriptive classes for which Chapman (1954: 27) felt that "There was little chance of definitely establishing a classification on the basis of specific cultural complex . . . ." Wood (1961: 87-99) used a version of Chapman's classification but also delineated a series of descriptive cultural units. These were established using test excavation data, and included projectile points as part of the trait list defining each unit. Unfortunately, these units have never been entirely satisfactory and have fallen into disuse. In Truman Reservoir itself, virtually no

systematic typological work, other than at Rodgers Shelter, was done prior to the Cultural Resources Survey. All National Park Service reports (Falk 1969, Falk and Lippincott 1974, Lippincott 1972, Vehik 1974, Chomko 1976) simply used a series of categories that usually were not standardized across reports and contained minimal comparison with established typologies, including those for Rodgers Shelter and Lake Pomme de Terre. They are of limited use for present purposes.

The surveys done as part of the Cultural Resources Survey collected over one thousand points – all from surface context. Because surface materials per se do not provide chronological information, that collection was analyzed by identification of specimens to previously described, named classes where possible. Comparisons were made with the classes described in the literature from throughout the Midwest, Plains, and Southeast. The residual points were placed in a series of classes devised for that collection and based on morphology (Roper and Piontkowski 1979). A similar approach has been followed here. The classes defined for this collection are defined and described in this paper.

PROCEDURES AND DEFINITIONS

Formation of Classes

A projectile point is defined as a bifacially worked chert artifact possessing a haft element at one end, and converging lateral margins that meet in a point at the other end (Roper 1977: 41, Roper and Piontkowski 1979, Lithics Laboratory Procedure Manual). Broken specimens are classed as points if they possess a haft element and are otherwise similar to complete specimens. This class of stone tools was separated from other classes, usually in the field laboratory, occasionally later. Although these specimens are treated as other stone tools and afforded normal lithics laboratory processing, they are also analyzed separately by procedures described herein.

All identification and classification was done by inspection rather than by any form of numerical analysis. Numerical classification was, however, attempted within several of the large and/or highly variable categories – usually with intuitively unsatisfactory results.

The points described in this report were, of course, collected during three seasons of field work. Preliminary sorting and identification was a continuous process throughout the three years, and the measurements and observations

used for the descriptions were generally done during and shortly after each field season (although all were done by the same person). Final formulation of categories was done after the final field season.

Where possible, identifications were made to classes previously established, defined, named, and validated. These included both those also used in the Cultural Resources Survey report (Roper and Piontkowski 1979) and additional classes newly identified. As before, residual points were included in a series of morphological classes established for this body of material. These classes do not necessarily correspond to those used during the Cultural Resources Survey, although some effort has been expended to make comparisons where possible.

Measurements and Observations

A series of metric and non-metric observations were made on each specimen. These are in no way suitable for numerical classification; rather, they are intended solely for description of present classes and comparison with those presented in the literature. These measurements and observations are identical to those made on specimens collected during the Cultural Resources Survey. These definitions are therefore largely repeated from those given in the report of the Cultural Resources Survey.

ELEMENTS OF A POINT (Fig. 1)

Point of juncture: a point where one element of the specimen joins another element (Binford 1963: 196).

Haft element: the proximal element of a point, defined by "notching, constriction, edge dulling, or other alteration for the assumed purpose of hafting" (Ahler 1971: 21).

Blade element: "the area delimited by the distal points of juncture of the haft element and the tip" (Binford 1963: 197).

Base: the proximal transverse edge of the haft element, delimited by the points of juncture with the lateral margins of the haft element.

Tip: "the point of juncture between two lateral edges of the distal segment of the projectile"; it is "the most distal point of the projectile" (Binford 1963: 197).

Notch: a purposeful indentation, placed for the presumed purpose of hafting, in either the lateral margin, corner, or base of a specimen.

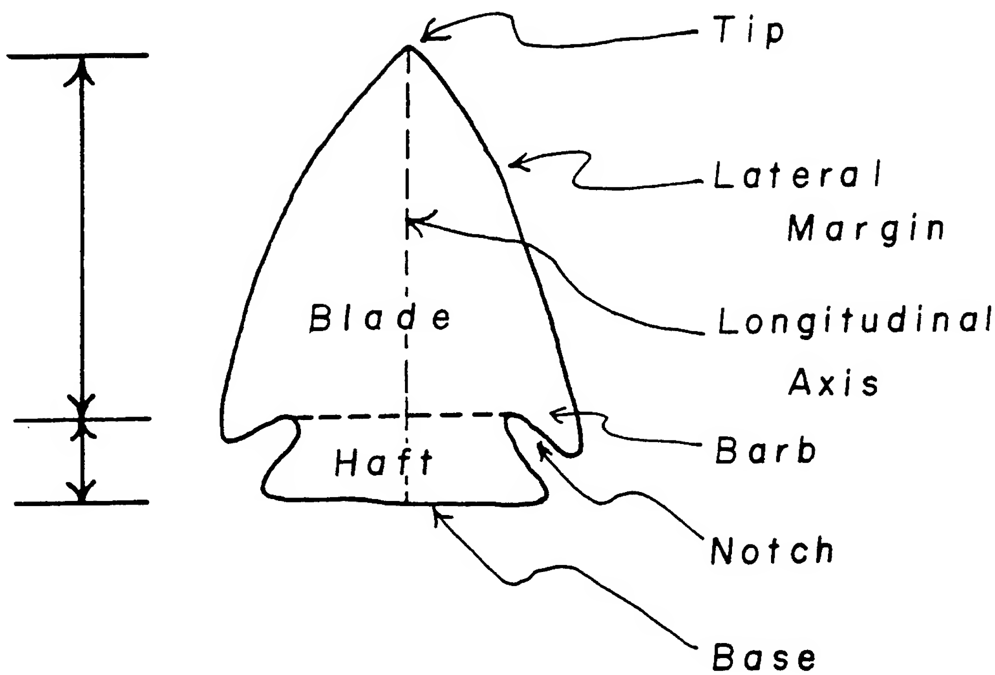


Figure 1. Elements of a projectile point.

QUANTITATIVE OBSERVATIONS (Fig. 2)

Length: the maximum length of the specimen, measured from the base to the tip along the longitudinal axis of the specimen. This and all other measurements are made with vernier calipers and read to the nearest millimeter.

Width: the maximum width of the specimen, regardless of where it occurs. It is measured perpendicular to the longitudinal axis.

Thickness: the maximum thickness of the specimen.

Haft length: the length of the haft element, measured along the longitudinal axis, from the base to a line marking the distal edge of the haft element.

Basal width: the maximum width of the base, measured between the points of juncture of the base with the lateral margins of the haft element.

QUALITATIVE OBSERVATIONS (Fig. 3)

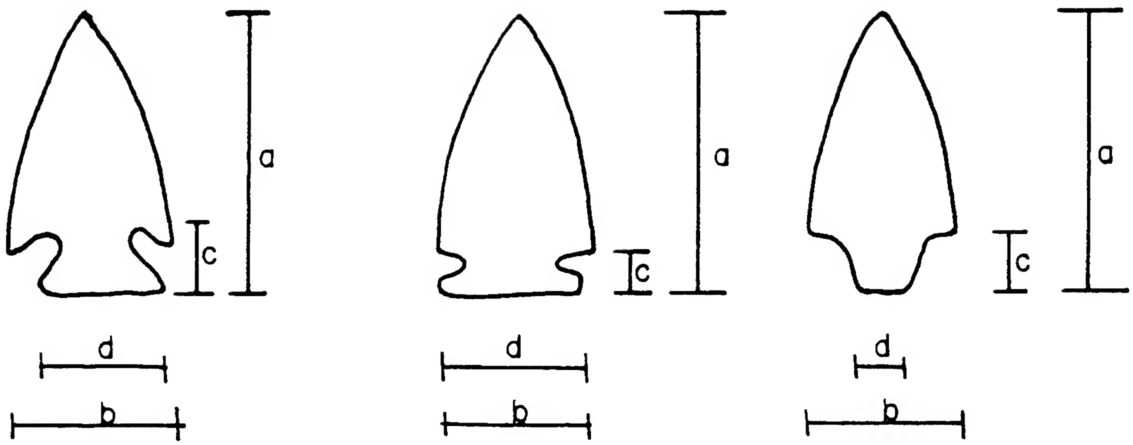
Lateral margin morphology: convex, straight, concave, angular, recurvate, or reworked to a drill or scraper (Fig. 3a).

Basal morphology: convex, concave, or straight (Fig. 3b).

Haft morphology: corner-notched – the distal point of juncture of the notch is with the lateral margin, the proximal point of juncture is with the base; side-notched – both points of juncture of the notch are with the lateral margins of the specimen; basal-notched – both points of juncture of the specimen are with the base; contracting stem – the lateral margins of the haft element converge towards one another; straight-stemmed – the lateral margins of the haft element are parallel to one another (Fig. 3c). On lanceolate specimens the haft element is defined only by a slight constriction and/or grinding on the proximal portions of the lateral margins.

Lateral grinding, basal grinding, basal thinning: recorded as present or absent. Basal thinning is considered to be present only in those cases in which flakes originating at the base and parallel to the longitudinal axis of the point are driven off from both faces.

Heat damage: recorded as present or absent. Heat damage includes potlidding, crazing, crenated fracturing, or other damage produced as a result of overheating the



a = Maximum length

b = Maximum width

c = Haft length

d = Base width

Figure 2. Quantitative observations on projectile points.

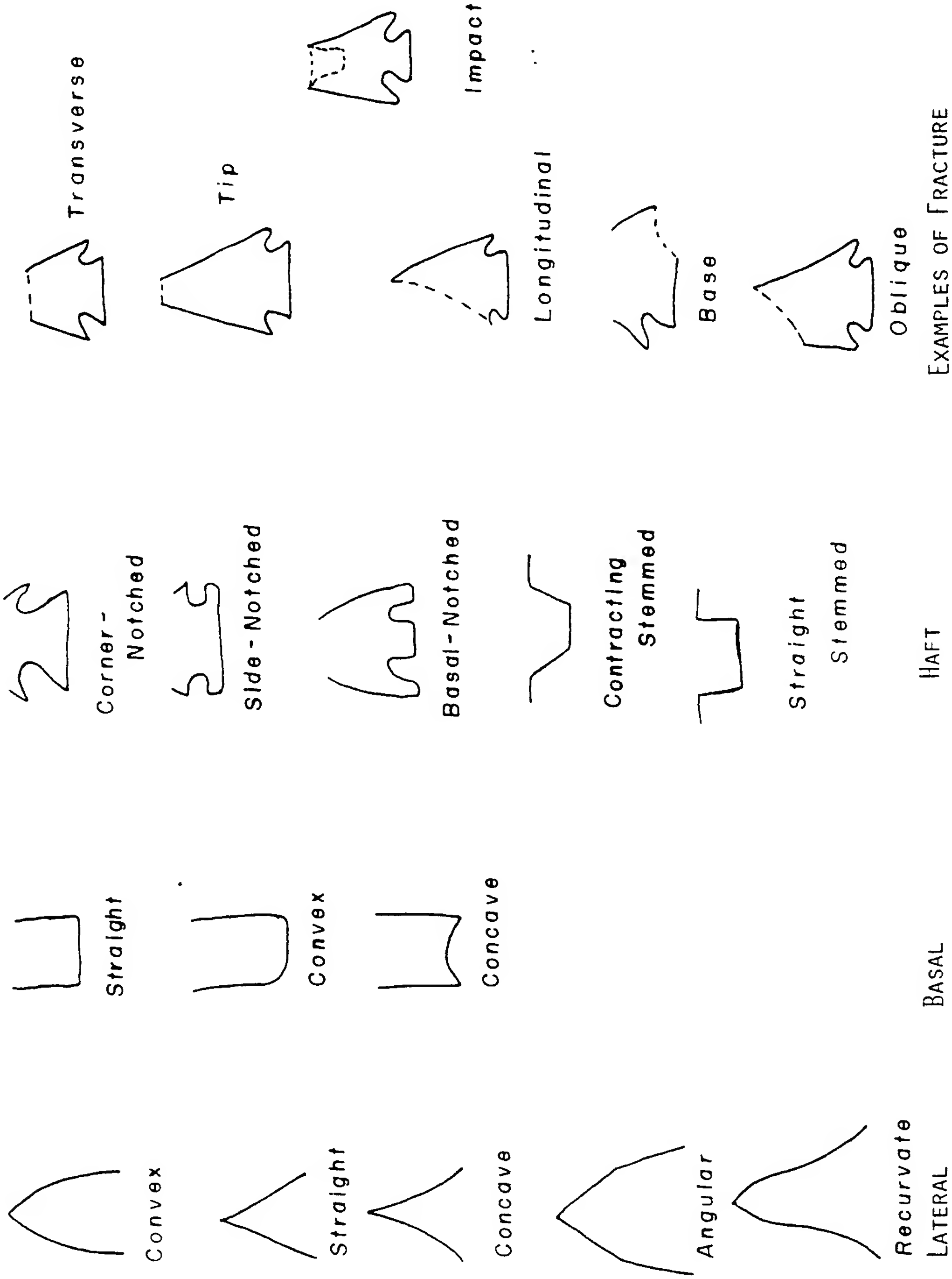


FIGURE 3. QUALTATIVE OBSERVATIONS

chert. This variable is coded present only when actual damage to the specimen occurred and is not intended to account for thermal pretreatment of cherts.

Blade beveling: present or absent.

All data are punched on computer cards and duplicated on magnetic tape, currently filed at the Campus Computing Center at the University of Missouri-Columbia. Each record is formatted for analysis with the Statistical Package for the Social Sciences (SPSS: Nie et al. 1975, Hull and Nie 1979). All data are formatted identically to the Cultural Resources Survey, thus allowing the ability to make direct comparisons across collections.

THE COLLECTIONS

The collections from the 1977-1979 survey, testing, and excavation in Truman Reservoir contain a total of 1183 items classified as projectile points. These are defined and described herein with an emphasis on projectile points as chronological indicators. Where possible, an established type name is given. These are indicated by the use of upper case letters in the description heading. Where an established name is not known, a brief descriptive heading is given. This is indicated by the use of lower case letters.

The categories described herein are not arranged strictly in numerical order. It seemed more logical to arrange them by morphological groups and to arrange these groups in an order that roughly follows the order in which they predominated.

Lanceolate Points

Category 385 – unfluted Paleo-Indian Lanceolate – n = 1
(Plate 1a)

Basic description:

Blade: broken across upper part of haft

Haft: distinguished from the blade apparently by the presence of heavy grinding on the lateral margins; parallel-sided; two superimposed thinning flakes have been removed from one face; the edges of both faces exhibit regular fine parallel flaking; the cross-section is very thin and lenticular.

Base: complexly concave; that is, a moderate concavity extends inward for 6 mm from each corner, then,

at a distinct point of juncture, becomes a considerably deeper, almost semi-circular concavity; heavily ground, particularly near the corners.

Size:

Length: incomplete

Width: 26 mm, but probably incomplete

Thickness: 4.7 mm

Haft length: incomplete, but probably not much more than the remaining 23 mm

Basal width: 26 mm

Comments and temporal position:

Almost certainly Paleo-Indian. Its lack of a true flute may remove it from the category of Clovis; however, it is in every other way comparable to Clovis specimens from the eastern United States (Roper 1981). Unfluted Paleo-Indian forms are, however, also characteristic of the late Paleo-Indian Plano Tradition (Mason 1962, Stephenson 1965).

Category 349 – PLAINVIEW – n = 2 (Plate 1b, d)

Basic description:

Blade: long and narrow, with excurvate lateral margins formed by parallel flaking

Haft: distinguished from the blade only by the presence of grinding on the lateral margins; parallel-sided; basal thinning flakes have been removed from one face of each specimen.

Base: concave; ground

Size:

Length: neither length is intact

Width: neither width is intact

Thickness: 5 and 8 mm

Haft length: neither haft length is intact, however, they are at least, but probably not much more than, 20 and 24 mm

Basal width: 11 and 20 mm

Temporal and spatial distribution and references:

Plainview points were named at the Plainview Site in northwest Texas (Sellards, et al. 1947) and are largely known from the Southern Plains (Shafer 1978: 20; Johnson and Holliday 1980: 103) although some (e.g., Wormington 1957: 107) suggest they are more widespread. A single specimen was found at the bottom of Rodgers Shelter (Wood and McMillan 1967: 54) and another specimen was collected from the surface of a nearby site on the Pomme de Terre River (Roper and Piontkowski 1979). Two are reported from the Montgomery Site on the Sac River below Stockton Dam (Collins, et al. 1979).

Plainview points are dated at several sites. Johnson and Holliday (1980: 104) accept only the dates from the Lubbock Lake and Bonfire Shelter sites in Texas as good dates and pertaining to Plainview. Five dates from these two sites are 10,230±160 B.P., 9920±150, and 10,100±300 at Bonfire Shelter, and 9883±350 and 9960±80 at Lubbock Lake (Johnson and Holliday 1980: 104). Frison (1976: 24) has recently obtained a date of 9700±620 for a Plainview-like point at Medicine Lodge Creek, Wyoming. All these dates are consistent with each other, as are the dates of 10,530±650 and 10,200±330 B.P. (Kay 1978) for the lowest levels at Rodgers Shelter and 9800 B.P. from below the cultural horizon at the Montgomery Site (Collins, et al. 1979).

Category 350 – DALTON – n = 5 (Plate 1c, e-g)

Basic description:

Blade: lateral margins of the single sufficiently unbroken specimen are generally straight

Shoulders: distinct on two specimens on which shoulders remain

Haft: delineated by a slight constriction below the shoulders, slightly incurvate, flaring slightly to the juncture with the base

Base: concave; ground; meets the lateral margins of the haft element in a slightly flared ear

Note: None of these specimens is classically Dalton; however, all have sufficiently distinct Dalton features to justify the classification.

Size:

Length: one intact length is 43 mm, although it is a small specimen

Width: two intact widths are 18 and 25 mm

Thickness: 7 to 10 mm ($\overline{X}$ = 8.0, s = 1.4, n = 4)

Haft length: 11 to 23 mm (11 mm specimen is atypical) ($\overline{X}$ = 18.0, s = 6.2, n = 3)

Basal width: 12 to 26 mm ($\overline{X}$ = 19.6, s = 5.5, n = 5)

Temporal and spatial distribution and references:

Although Dalton points were first named at the Dalton Site on the lower Osage River in Missouri (Chapman 1975: 135), they are known throughout the deciduous forests of eastern North America (Tuck 1974: 73-75). In the Truman Reservoir area, they comprised the earliest occupation at Rodgers Shelter (Kay 1978) along with a Plainview point, and occurred in small quantity on sites recorded during the Cultural Resources Survey (Roper and Piontkowski 1979). An extensive Dalton occupation occurs at the Montgomery Site on the Sac River (Collins, et al. 1979).

Dalton occupations are usually assumed to occur between 10,000 and 9000 years ago (Chapman 1975) or 8000 to 6000 B.C. (Morse 1973: 23). Dates of 10,530±650 B.P. and 10,220±330 B.P. are associated with the Dalton occupations at Rodgers Shelter and the 9800 B.P. date at the Montgomery Site (Collins, et al. 1979) is below the cultural horizon. This date accords well with dates of 10,651±650 and 9101±440 at Modoc Rock Shelter in Illinois (1959: 18), 9640±450, 8920±400 (DeJarnette, Kurjack, and Cambron 1962: 85), 9440±400, 9340±400, and 9040±400 (Crane and Griffin 1965: 133) at Stanfield-Worley Shelter in Alabama. A date of 8550±220 at Pigeon Roost Creek site in Cannon Reservoir (Teter and Warren 1979: 223) seems late for Dalton, but yet is slightly earlier than a date of 8120±350 B.P. reportedly associated with a Dalton point at Arnold Research Cave (Shippee 1966: 35).

Category 335 – SEDALIA – n = 16 (Plate 1j-k)

Basic description:

Blade: long and relatively narrow, with excurvate or recurvate lateral margins

Shoulders: the haft element is distinguished from the blade by a very slight and normally not very distinct constriction

Haft: straight to slightly incurvate lateral margins

Base: usually concave but occasionally straight; sometimes joins with the lateral margins of the haft in slightly flared ears

Size:

Length: three intact lengths are 93, 105, and 113 mm ($\overline{X}$ = 103.7, s = 10.1)

Width: 26 to 49 mm ($\overline{X}$ = 32.6, s = 7.2, n = 8)

Thickness: 7 to 25 mm ($\overline{X}$ = 11.2, s = 4.1, n = 15); however, all but one range 7 to 12 mm ($\overline{X}$ = 10.2, s = 1.5, n = 14)

Haft length: 6 to 39 mm ($\overline{X}$ = 27.8, s = 7.7, n = 13); however, all but one range 25 to 39 mm ($\overline{X}$ = 29.7, s = 4.2, n = 12)

Basal width: 15 to 30 mm ($\overline{X}$ = 20.3, s = 5.2, n = 10)

Temporal and spatial distribution and references:

Sedalia points are described by Chapman (1975: 255-256) from sites in Pettis County, Missouri. They are best known from Pettis County, but also occur in some quantity to the north and east in the Cannon Reservoir area (Klippel 1969) in Missouri, and the Koster (Cook 1976) and Airport (Roper 1978) sites in Illinois. They also occur in some quantity in the Truman area. Roper and Piontkowski (1979) identified 29 specimens during the Cultural Resources Survey. Phillips Spring (23HI216) also contains an extensive Sedalia occupation (Kay 1979a).

One Sedalia component at Phillips Spring has associated radiocarbon dates of 3927±61 B.P., 3938±66 B.P., 3999±70 B.P. and 3998±71 B.P. (Kay 1979a: 47). The single date of 3950±75 B.P. at Koster (Cook 1976: 65) could hardly be more consistent with these dates. Kay (1979b), however, asserts that Sedalia and other Late Archaic phases are contemporaneous for about 1500 years beginning around 4000 B.P. Projectile point distributions at the Cross Timbers Site (23HI297) support that late association. A Sedalia specimen was recovered there from a component which included Etley, Smith, Table Rock Stemmed, and Standlee points. That component has been tentatively dated to 425 B.C.±250 by thermoluminescence techniques (see Appendix B, Vol. I).

Category 344 — NEBO HILL — n = 2 (Plate Ih-i)

Basic description:

Blade: long, narrow blades, with diamond-shaped cross-section; lateral margins are slightly excurvate

Haft: delineated by the presence of grinding on the lateral margins

Base: slightly convex and ground

Size:

Length: neither specimen is intact

Width: the single intact width is 18 mm

Thickness: 9 and 11 mm

Haft length: not intact

Basal width: not intact

Temporal and spatial distribution and references:

Nebo Hill points were first described by J. M. Shippee (1948) at a site in the Kansas City area of Missouri. They were more fully described by Shippee in 1957 (Shippee 1957). They are best known in the Kansas City area of western Missouri (e.g., Reid 1979, Reeder 1978) but are distributed somewhat more widely, including the Grand (Vehik 1971) and Chariton Rivers (Tandarich and Reagan 1978) areas of northwest Missouri and into Iowa (Rowe 1952, Reagan, p.c.), the Hillsdale Lake area of eastern Kansas (Blakeslee 1979), and the Coffey Site in northern Kansas (Schmits 1976: 57).

Four specimens were recorded during the Stage 1 and 2 surveys in Truman Reservoir (Roper and Piontkowski 1979), the first ones reported from the area. All four of these specimens, plus both of the present specimens were collected in Henry County from sites along the South Grand River. In Truman they have, so far, always appeared in surface context and usually with Sedalia points, an association not uncommon in the Kansas City area also (Reeder 1978, Reid 1979).

Shippee (1948) originally regarded Nebo Hill points as Paleo-Indian—Early Archaic and Chapman (1975) seems uncertain as to their placement. Recently obtained dates, however, are 1605$\pm$65 B.C. (3555 B.P.) at the Nebo Hill type site (23CL11; Reid 1979: 18) and 1020$\pm$490 B.C. (2970 B.P.) at the Sohn Site (23JA110; Reeder 1978: 162).

Side-Notched Points

Category 384 — HARDAWAY SIDE-NOTCHED — n = 2 (Plate 1-l-m)

Basic description:

Blade: broadly triangular with excurvate lateral margins

Shoulders: distinct but unbarbed

Notches: semi-circular and at a slight angle to the long axis of the point

Haft: short and broad

Base: concave; the base and lateral margins of the haft element meet in flared eared corners

Size:

Length: neither length is intact

Width: neither width is intact

Thickness: 7 and 8 mm

Haft length: 12 and 14 mm

Basal width: 25 and 26 mm

Temporal and spatial distribution and references:

There is little doubt that these are examples of the Hardaway Side-Notched type described by Coe (1964: 67) from the Hardaway Site in North Carolina. The type is widespread in the southeast (Coe 1964: 120) and has several other occurrences in Missouri. These include several collected during the Cultural Resources Survey (but identified later) and one from the Montgomery Site in Cedar County (Collins, et al. 1979). They are associated with Dalton forms and probably date prior to 9000 B.P.

Category 376 – Dalton variant – n = 4 (Plate 1n-q)

Basic description:

Blade: the single intact blade has excurvate lateral margins on a blade that has beveling on both edges of both faces

Shoulders: obtuse and narrow

Notches: shallow and broad, being largely a constriction below the shoulders, gradually flaring below the constriction

Haft: has gradually flaring lateral margins and rounded corners; laterally ground on 3 specimens

Base: deeply concave; ground on 3 specimens

Size:

Length: the single intact length is 36 mm

Width: the single intact width (same specimen) is 27 mm

Thickness: 7 to 10 mm ($\overline{X}$ = 8.3, s = 1.5, n = 3)

Haft length: 15 to 19 mm ($\overline{X}$ = 17.7, s = 2.3, n = 3)

Basal width: 16 and 21 mm on two intact specimens

Temporal and spatial distribution and references:

These specimens are a variant on Dalton. They are not unlike Coe's (1964: 64) Hardaway blades from North Carolina. In Missouri, they occur at Graham Cave and Arnold Research Cave. At the latter, a specimen similar to members of this class was associated with a radiocarbon date of 8190±400 years ago (Shippee 1966: 35). A single specimen also occurred in association with Rice Lobed, Graham Cave, and Rice Lanceolate in the lower level of Tick Creek Cave on the Gasconade River (Roberts 1965: 14).

Category 374 – large bifurcated base – n = 2 (Plate 1r-s)

Basic description:

Blade: long relative to width, with excurvate lateral margins

Shoulders: obtuse

Notches: broad and hyperbolic, with indistinct points of juncture with the lateral margins

Haft: short relative to the total length of the specimen, with well rounded corners; one specimen has light grinding on the lateral margins

Base: deeply concave but narrow, giving the base a bifurcated appearance; one specimen has grinding on the base

Size:

Length: neither specimen has an intact length

Width: 25 and 28 mm

Thickness: 7 and 9 mm

Haft length: 14 and 16 mm

Basal width: neither basal width is intact

Temporal and spatial distribution and references:

These specimens are undoubtedly part of the Early Archaic bifurcated base tradition as exemplified at the St. Albans Site in West Virginia (Broyles 1966) and the Rose Island, Icehouse Bottoms, and other sites in the Tellico Reservoir in southeast Tennessee (J. Chapman 1975, 1977, 1978). The Truman specimens do not readily fit any of the major bifurcated base point categories; however, it is clear that there is a residual class of miscellaneous bifurcate base forms, into which these specimens could easily fall.

On the basis of a large series of radiocarbon dates, J. Chapman (1976: 9) dates the bifurcate base point tradition 8750 to 8050 B.P. While the Truman specimens cannot be placed this exactly, their associations suggest an early temporal placement. One specimen was collected during Chomko's (1979) testing at 23BE214 and was reexamined as part of additional testing at the site. Other specimens from this site included Plainview and Dalton. The other came from the very bottom of the excavation at 23HI297. Also similar is a point reported by Piontkowski from below two buried paleosols at the Wolf Creek site on the Osage River (Piontkowski 1979).

Category 375 — GRAHAM CAVE(?) — n = 7 (Plate 1t-v)

Basic description:

Blade: excurvate lateral margins; unusually well-flaked with even flaking along both edges of both faces

Shoulders: distinct, forming a right angle

Notches: nearly semi-circular, meeting the lateral margins of the point at nearly right angles

Haft: proportionally long and with a massive squared appearance

Base: straight to very slightly concave, meeting the lateral haft margins at nearly a right angle

Size:

Length: two intact lengths are 38 and 46 mm

Width: 25 - 31 mm ($\overline{X}$ = 27.7, s = 3.1, n = 3)

Thickness: 7 - 9 mm ($\overline{X}$ = 7.9, s = .9, n = 7)

Haft length: 13 - 17 mm ($\overline{X}$ = 14.9, s = 1.8, n = 7)

Basal width: 21 - 29 mm ($\overline{X}$ = 23.6, s = 3.3, n = 5)

Temporal and spatial distribution and references:

These points are similar to Graham Cave points, although their straight to slightly concave bases are at variance with Chapman's (1975: 248) definition of Graham Cave as having concave, usually deeply concave, bases.

Graham Cave points are widely distributed in Missouri (Chapman 1975) and adjacent portions of Illinois (Scully 1951, Fowler 1959) during the Early Archaic period. Chapman (1975: 249) estimates it to date 10,000 to 7000 B.P. At Rodgers Shelter, Graham Cave points are most common in Horizons 9 and 8 which Kay (1978) dates between 9500 and 8100 years ago, thus according well with Chapman's estimate.

Category 378 — BIG SANDY — n = 8 (Plate 2i-l)

Basic description:

Blade: lateral margins are excurvate and usually exhibit evenly executed flaking around all edges; only a single specimen showed blade beveling

Shoulders: distinct, and at a right angle to the long axis of the point

Notches: distinct and usually semi-circular

Haft: proportionally short, with lateral grinding on two specimens

Base: slightly concave to concave, exhibiting light grinding on 2 specimens

Size:

Length: the single intact length is 38 mm

Width: 22 to 25 mm ($\overline{X}$ = 23.5, s = 1.7, n = 4)

Thickness: 7 to 9 mm ($\overline{X}$ = 8.1, s = .7, n = 7)

Haft length: 13 to 17 mm ($\overline{X}$ = 14.4, s = 1.6, n = 7)

Basal width: 16 to 22 mm ($\overline{X}$ = 19.8, s = 2.4, n = 6)

Temporal and spatial distribution and references:

These specimens may almost certainly be identified as Big Sandy in the sense of the definition given by Chapman (1975: 242, et passim). They closely resemble specimens illustrated by Logan (1952: 32) from the lowest levels at Graham Cave. Big Sandy are distributed throughout the southeastern United States (see Tuck 1974: 75-76 for discussion; also Griffin 1974: 94). Tuck (1974: 75) suggests that Big Sandy succeeds and derives from the preceding Dalton. This accords well with evidence from Stanfield-Worley Shelter in Alabama where Dalton and Big Sandy are both common in the lowest cultural zone (DeJarnette, Kurjack, and Cambron 1962: 82), from Graham Cave, whose lowest levels also contained both Dalton and Big Sandy points (Logan 1952), and possibly also from Modoc Rock Shelter (Fowler 1959). They seem, however, to be absent from Rodgers Shelter, as Kay (1978) neither describes such a category, nor illustrates any specimens that belong to it.

Category 368 – small triangular bladed, side-notched darts – n = 10 (Plate 2a-d)

Basic description:

Blade: most are badly broken, but appear to have been generally an equilateral triangle with slightly excurvate to excurvate lateral margins

Shoulders: sharp and distinct, sometimes with very short barbs

Notches: deep, usually elliptical and at an angle to the long axis

Haft: short, rapidly flaring to a juncture with the base; the notch-lateral margins juncture to base corner distance is short; lateral margin grinding is present on 3 specimens

Base: slightly concave, ground on three specimens

Size:

Length: the single intact specimen is 22 mm

Width: 16 to 17 mm ($\overline{X}$ = 16.3 mm, s = .6, n = 3)

Thickness: 5 to 6 mm ($\overline{X}$ = 5.7, s = .5, n = 9)

Haft length: 8 to 11 mm ($\overline{X}$ = 10.1, s = 1.2, n = 7)

Basal width: the single intact specimen is 12 mm

Temporal and spatial distribution and references:

These specimens fit the description of the triangular side-notched points found at the Itasca Site in Minnesota (Shay 1971: 56) and dated between 8000 and 7000 B.P. They are also similar to specimens from the Simonsen and Hill sites in Iowa and Logan Creek in Nebraska (cited in Shay 1971: 56), all dated between 8500 and 7000 B.P.

Category 369 – concave based, side-notched dart – n = 2 (Plate 2e-f)

Basic description:

Blade: both specimens are too broken to accurately describe

Shoulders: distinct and unbarbed

Notches: small and nearly semi-circular, set at nearly a right angle to the long axis of the specimen

Haft: long; the distance from the juncture of the base and the lateral haft margin to the proximal point of juncture of the notch with the lateral margin is comparatively great

Base: deeply concave; heavily ground

Size:

Length: neither specimen is intact

Width: 19 and 20 mm

Thickness: 6 and 7 mm

Haft length: 11 and 12 mm

Basal width: 12 and 15 mm

Comments and temporal position:

These points are distinguished from those in Category 368 by the deeper concavity of their base, and the form of their notches. They may be a variant of Plains Archaic small side-notched points. There is no confirmation either from comparisons with published descriptions or provenience, except that one of these specimens is from a site (23BE869) that contains several other pre-Hypsithermal types, including Dalton and Graham Cave.

Category 370 — straight-based, side-notched — n = 2 (Plate 2g-h)

Basic description:

Blade: although both are broken, they appear to have been relatively long in relation to width; lateral margins are slightly concave; both specimens exhibit fine, nearly parallel chipping

Shoulders: moderately distinct, but not barbed

Notches: semi-circular and broad

Haft: side-notched with squared corners

Base: straight

Size:

Length: neither length is intact

Width: the single intact width is 18 mm

Thickness: 5 and 6 mm

Haft length: 9 and 12 mm

Basal width: the single intact width is 13 mm

Temporal position and references:

These two specimens are similar to the Brannon Side-Notched type defined by Cook (1976: 148-150) from Horizon 6 at the Koster Site in Illinois. The Truman specimens are smaller than the means for the Koster specimens, but Cook's illustrations (1976: 171) make it clear that his category exhibits a high degree of size variability. At Koster, these points cluster in middle Horizon 6, dated between 5500 and 5000 years ago (Cook 1976: 70).

Category 371 — flared Base A - JAKIE STEMMED — n = 5 (Plate 2m-o)

Basic description:

Blade: triangular with highly excurvate lateral margins; three of five specimens exhibit beveling on the lateral margins

Shoulders: exhibit prominent but short barbs

Notches: elliptical and at an acute angle to the long axis of the point

Haft: has a constriction at the neck; flaring out to the juncture with the base

Base: concave; joining with the lateral margins of the haft in a distinct flare; asymmetrical

Size:

Length: two intact lengths are 37 and 42 mm

Width: the single intact width is 28 mm

Thickness: 5 to 8 mm ($\overline{X}$ = 6.4, s = 1.1, n = 5)

Haft length: 11 to 15 mm ($\overline{X}$ = 12.6, s = 1.7, n = 5)

Basal width: 18 to 24 mm ($\overline{X}$ = 20.3, s = 3.2, n = 3)

Temporal and spatial distribution and references:

These are probably Jakie Stemmed (Chapman 1975: 250-251) points named at Jakie Shelter (23BY388) in the Table Rock Reservoir (Marshall and Chapman 1960: 1113). Their occurrence there is with Big Sandy points (formerly called White River Archaic; Marshall and Chapman 1960: 1113). They are also common at Tick Creek Cave (23PH145) on the Gasconade River. Here they occurred stratigraphically just above Rice Lobed, Graham Cave, and lanceolate forms (Roberts 1965: 11). Kay's (1978) Jakie Stemmed points from Rodgers Shelter do not resemble the published descriptions of Jakie Stemmed; his Rodgers Flared category is considerably more similar. These occur in greatest number in Rodgers Horizon 5, estimated to date 6700 to 5200 years ago (Kay 1978). Although no other absolute dates are available, the stratigraphy at Rodgers is consistent with that at Jakie Shelter and Tick Creek Cave. All specimens collected during 1977 to 1979 are from the surface.

Category 372 – flared Base B – n = 9 (Plate 2p-s)

Basic description:

Blade: approaches an equilateral triangle, although several broken specimens may once have been more elongated; lateral margins are straight to slightly convex

Shoulders: distinct, but only a single specimen has short barbs

Notches: shallow and very elongated, at an acute angle to the long axis

Haft: constricted at the neck, flaring at the juncture with the base; three specimens exhibit light grinding

Base: slightly concave to concave, three specimens exhibit light grinding

Size:

Length: no length is intact

Width: two intact widths are 22 and 29 mm

Thickness: 6 to 8 mm ($\overline{X}$ = 6.7, s = .5, n = 6)

Haft length: 13 to 21 mm ($\overline{X}$ = 16.3, s = 3.3, n = 6)

Basal Width: 17 to 24 mm ($\overline{X}$ = 20.4, s = 2.5, n = 7)

Temporal and spatial distribution and references:

These may be a Jakie Stemmed variant, in which case, all comments made for Category 371 would also apply to this category. All of these specimens are also from surface context; five of the nine from a single site, 23HI299, where the only other specimen collected was a Dalton variant (Category 376).

Category 320 — small, shallow-side-notched — n = 12 (Plate 2t-v)

Basic description:

Blade: very short and broad, triangular with irregular, probably reworked, edges; one specimen has a beveled blade

Shoulders: weak and rounded

Notches: extremely shallow and broadly parabolic, inserted at approximately 90^{o} to the medial axis

Stem: slightly expanding with straight outline

Base: straight to subconvex with angular corners

Size:

Length: 19 to 43 mm ($\overline{X}$ = 31.6, s = 8.9, n = 8)

Width: 16 to 23 mm ($\overline{X}$ = 20.5, s = 2.1, n = 10)

Thickness: 5 to 7 mm ($\overline{X}$ = 5.8, s = .7, n = 12)

Haft length: 11 to 17 mm ($\overline{X}$ = 13.1, s = 1.7, n = 12)

Basal width: 15 to 23 mm ($\overline{X}$ = 19.5, s = 2.5, n = 11)

Comments and temporal position:

These points are similar in form to Rice Side-Notched points with the exception of a short, stubby blade and a generally smaller size. No specimens of this form have been described previously. A few occur in the burial tumuli of southwest Missouri and probably date into the Woodland period. One specimen has been recovered from an Afton component at an open site, 23HI297, which has been dated to the Middle Woodland period by thermoluminescence. Three dates from that component are A.D. 342±130, A.D. 200±175, and A.D. 236±167 (see Appendix B, Vol. I). Another specimen of this type was recovered in a separate area of that site. The single component there has been dated at A.D. 483±144 and A.D. 397±152.

Category 321 – small, narrow, side-notched, sharply expanding-stemmed – n = 17 (Plate 2w-y)

Basic description:

Blade: long, narrow triangular blade with well-flaked straight edges

Shoulders: straight and angular

Notches: fairly shallow and narrow parabolic notches inserted at approximately 80° to 90° to the medial axis

Stem: sharply expanding; two specimens have grinding on the haft element

Base: straight with very rounded corners; as wide as or wider than width at shoulders; two are basally ground

Size:

Length: no complete specimens

Width: 18 to 28 mm ($\overline{X}$ = 23.0, s = 3.1, n = 14)

Thickness: 5 to 8 mm ($\overline{X}$ = 6.5, s = .9, n = 17)

Haft length: 10 to 14 mm ($\overline{X}$ = 11.4, s = 1.2, n = 17)

Basal width: 16 to 23 mm ($\overline{X}$ = 19.9, s = 2.7, n = 8)

Comments and temporal position:

No points of this type have been described previously in the literature. In size they are similar to corner-notched forms which occur in Late Archaic and Woodland components in Truman Reservoir. Based on stratigraphic evidence from two loci at 23HI297, these side-notched forms are assigned to the Woodland period. They appear there in stratigraphic units which have been dated at A.D. 911±103 and at A.D. 483±144 and A.D. 397±152. At another site a category 321 specimen occurs in a Late Archaic component dated at 1374 B.C. ±282 (see Appendix B, Vol. I).

Category 325 – RICE SIDE-NOTCHED – 71 specimens (Plate 3a-m)

Basic description:

Blade: triangular with either straight or convex edges; quality of flaking tends to be poor, with mostly percussion flaking and little retouch, leaving edges fairly irregular; cross-section is moderately thick and irregularly bi-convex; many have been reworked, leaving a short stubby blade; five specimens are beveled

Shoulders: poorly defined, weak and rounded, often grading directly into the shallow side-notches

Notches: very shallow, broad, inserted at approximately 90° to the medial axis and often asymmetrical; sometimes appears as just a slight constriction below the shoulders of the point

Stem: very broad, expanding with either a concave or nearly straight outline; five specimens have grinding on their lateral margins

Base: usually straight, but occasionally slightly subconcave or subconvex; corners are usually irregularly rounded and sometimes bulbous or flaring; five have ground bases

Size:

Length: 39 to 73 mm ($\overline{X}$ = 5.0, s = 9.5, n = 18)

Width: 23 to 40 mm ($\overline{X}$ = 28.8, s = 3.7, n = 54)

Thickness: 6 to 11 mm ($\overline{X}$ = 8.6, s = 1.6, n = 71)

Haft length: 10 to 30 mm ($\overline{X}$ = 18.3, s = 3.7, n = 68)

Basal width: 18 to 34 mm ($\overline{X}$ = 26.0, s = 3.6, n = 50)

Spatial and temporal distribution and references:

Rice Side-Notched points were named by Bray (1956) from specimens at the Rice Site. Dart points of this type seem to be most abundant in southwest Missouri, although they do occur in small numbers in immediately surrounding areas. They are so ubiquitous in burial tumuli that Wood (1961, 1967) uses Rice Side-Notched, along with Scallorn arrowpoints, as diagnostic traits of the Fristoe Burial Complex. They are abundant in open and shelter sites in southwest Missouri, as well. One of the most numerous of all dart points recovered in the Truman surveys, they are second only to Standlee points in frequency of occurrence. Rice Side-Notched points also occur in smaller numbers in Oklahoma (Purrington 1971: 96), northward to the Missouri River and Kansas City (Shippee 1967) and eastward in the Gasconade River area (McMillan 1965).

Most archeologists working in the region in and around southwest Missouri tend to treat the Rice Side-Notched point type as a regionally isolated type. It is true that in many of its attributes (especially the shallowness of the notches and crudeness of workmanship) it seems to be a unique type. However, the Rice Side-Notched type bears a formal resemblance to Ansell, a type originally named from Illinois specimens (Montet-White 1968).

Ansell points are found on late Middle and Late Woodland sites in Illinois, Missouri and Iowa, thus dating around A.D. 500. A similar temporal placement, in the Late Woodland period, has been postulated for the Rice Side-Notched type, based on mortuary assemblages (Goldberg Vol. III and excavations at open sites. Specimens occur in a component at 23HI297 which has been dated at A.D. 483±144 and A.D. 397±152. In several sites they co-occur with arrow points which persist until the Mississippian period. Three specimens from burial tumuli have been subjected to thermoluminescence dating determination: 23BE3 – A.D. 965±80; 23BE136 – A.D. 1100±50; and 23BE6 (Mound 2) – A.D. 1056±45 (see Appendix B, Vol. I).

Category 324 – shallow notched – n = 4 (Plate 3n-o)

Basic description:

Blade: triangular with straight to slightly excurvate lateral margins; one specimen was reworked to a drill

Shoulders: limited to being a distinct point dividing the divergent blade margins from the haft element

Notches: weak; broad, shallow indentations

Haft: has slightly incurvate sides

Base: concave, meets lateral margins of haft in sharply pointed ears, asymmetrical

Size:

Length: two unbroken specimens are 39 and 60 mm, a third specimen missing only a few mm of its tip is 52 mm long

Width: 27 to 32 mm ($\overline{X}$ = 28.8, s = 2.2, n = 4)

Thickness: 7 to 9 mm ($\overline{X}$ = 8.0, s = .8, n = 4)

Haft length: 14 to 28 mm ($\overline{X}$ = 16.5, s = 1.7, n = 4)

Basal width: 27 to 29 mm ($\overline{X}$ = 28.0, s = 1.0, n = 3)

Comments and temporal position:

These points are very similar to Rice Side-Notched but were separated from that highly variable class as a distinct variant. The single specimen from an excavated context was from the lowest level at 23HI297. Although that component is undated, its stratigraphic placement below an Etley point suggests that this is an early form, certainly earlier than its Late Woodland Rice Side-Notched counterpart.

Category 361 — small notched, rounded corners — n = 8 (Plate 2z-aa)

Basic description:

Blade: broken on most; one specimen has a triangular blade with straight lateral margins

Shoulders: angular and unbarbed

Notches: small, nearly semi-circular side notches

Haft: rapidly expanding lateral margins with the proximal end of the notch and basal corner forming a well-rounded corner

Base: slightly concave on one specimen, straight to convex on all others

Size:

Length: one nearly intact specimen is 39 mm long

Width: two intact widths are 27 and 36 mm

Thickness: 5 to 9 mm ($\overline{X}$ = 7.1, s = 1.1, n = 8)

Haft length: 13 to 19 mm ($\overline{X}$ = 15.9, s = 2.3, n = 7)

Basal width: 24 to 27 mm ($\overline{X}$ = 26.1, s = 1.5, n = 7)

Comments and temporal position:

Unknown. Most specimens are from surface context. A single specimen excavated at 23BE676 is from an unclear context.

Category 377 – weakly side notched – n = 5 (Plate 2bb-dd)

Basic description:

Blade: lateral margins are excurvate

Shoulders: indistinct and well-rounded

Notches: shallow and weakly formed

Haft: have a massive squarish appearance but, because of less careful workmanship, are less squared; ground on one specimen

Base: slightly concave; ground on one specimen

Size:

Length: 36 to 43 mm ($\overline{X}$ = 40.3, s = 3.8, n = 3)

Width: 21 to 27 mm ($\overline{X}$ = 24.0, s = 3.0, n = 3)

Thickness: 6 to 10 mm ($\overline{X}$ = 8.3, s = 1.7, n = 4)

Haft length: 13 to 19 mm ($\overline{X}$ = 16.6, s = 2.9, n = 4)

Basal width: 13 to 22 mm ($\overline{X}$ = 18.4, s = 3.5, n = 5)

Comments and temporal position:

Unknown. Possibly these are a variant on Graham Cave points; they are stylistically similar. However, a specimen of this type occurred in the lower part of a component at 23BE337 which contained Afton-like points (Category 316)

and dated at A.D. 620±110 and A.D. 634±109 (see Appendix B, Vol. I).

Category 379 — large lobed base — n = 2 (Plate 3p, r)

Basic description:

Blade: both are too damaged to describe

Shoulders: also damaged

Notches: damaged, but appear to have been relatively deep, intersecting the lateral margins at an obtuse angle

Haft: the intersection of the notch and the lateral margin is obtuse and diffuse, as is the intersection of the base and lateral margins, the corners therefore have a lobed appearance

Base: concave

Size:

Length: neither length is intact

Width: neither width is intact

Thickness: the single intact thickness is 11 mm

Haft length: neither haft length is intact

Basal width: 23 and 25 mm

Comments and temporal position:

Unknown. Both specimens are sufficiently damaged to make comparisons difficult and both are from surface context making provenience inconclusive.

Category 380 — small, lobed base — n = 2 (Plate 3q, s)

Basic description:

Blade: relatively long and narrow, with excurvate lateral margins; beveling is present on both edges of both faces of both specimens — it is accomplished by sufficiently fine chipping as to give the margins a finely serrated appearance

Shoulders: distinct but rounded

Notches: small and hyperbolic

Haft: very short relative to the overall length of the specimen

Base: convex and notably narrower than the shoulders

Size:

Length: the single intact length is 41 mm

Width: 17 and 21 mm

Thickness: both are 6 mm

Haft length: 12 and 13 mm

Basal widths: 9 and 11 mm

Comments and temporal position:

Unknown. Both of the present specimens are from surface context.

Category 381 — wide, side-notched — n = 7 (Plate 3t)

Basic description:

Blade: triangular, usually straight-sided, broad

Shoulders: distinct, but formed at an obtuse angle

Notches: side-notched, nearly semi-circular, perpendicular to the long axis of the point, proportionally small

Haft: short relative to total size of point, but very broad, notch-lateral margins juncture to base-lateral margin juncture is rounded

Base: slightly convex, point of juncture with lateral margin is rounded

Size:

Length: no length is intact

Width: two intact widths are 32 and 40 mm

Thickness: 6 to 9 mm ($\overline{X}$ = 8.0, s = 1.0, n = 7)

Haft length: 15 to 18 mm ($\overline{X}$ = 16.7, s = 1.2, n = 6)

Basal width: 25 to 28 mm ($\overline{X}$ = 26.3, s = 1.5, n = 3)

Comments and temporal position:

Unknown. All of the present specimens are from surface context.

Category 382 — poorly made side-notched — n = 4 (Plate 3u-x)

Basic description:

Blade: triangular, with generally straight sides, chipping is, however, irregular, leaving all specimens with an appearance of poor workmanship and/or much battering

Shoulders: distinct, but variable; one specimen appears to have a short barb

Notches: shallow, but otherwise somewhat variable, perpendicular to the long axis

Haft: short with rapidly flaring lateral margins

Base: convex

Size:

Length: no length is intact

Width: no width is intact

Thickness: 7 to 9 mm ($\overline{X}$ = 8.3, s = 1.0, n = 4)

Haft length: 12 to 16 mm ($\overline{X}$ = 14.3, s = 2.1, n = 3)

Basal width: no basal width is intact

Comments and temporal position:

Unknown. These have the superficial appearance and overall size of Hardaway points (Category 384), however, their generally beat-up condition makes confirmation difficult. One specimen is from 23BE214 which has yielded Dalton-Early Archaic time period points almost exclusively. All other specimens are, however, from surface context.

Category 383 — Miscellaneous side-notched — n = 4

1. This specimen has a badly impact fractured blade that once was quite broad and may have had excurvate lateral margins. The shoulders are now broken but were probably once barbed. The notches are set at an angle to the length of the point and are parabolic. The haft is short and at

the base is considerably narrower than the shoulders. The base is concave. Neither the length nor the width is intact. Thickness is 8 mm, haft length = 13 mm, basal width = 14 mm.

2. This specimen has excurvate lateral margins and is poorly manufactured, leaving it with a triangular cross-section. It is broken transversely about mid-blade. The shoulders are indistinct. The haft has only the slightest hints of notches. The base is slightly concave. Length and width are incomplete although the width is not much more than 23 mm. Thickness is 11 mm, haft length = 12 mm, basal width = 22 mm.

3. The blade of this specimen has a mid-blade oblique fracture, terminating at one notch. The one element lateral margin fragment appears to have been slightly excurvate. The shoulder is distinct and has a slight barb. The notches are narrow. The haft has rapidly expanding lateral margins and is long between the proximal notch juncture and the basal corner. The distance across the 2 proximal notch junctures is greater than the basal width but less than the shoulder width. The base is slightly convex. Length and width are incomplete; thickness is 7 mm, haft length = 13 mm, basal width = 17 mm.

4. This specimen was reworked to a drill but has been subsequently broken. The edges are regular and produced by fine parallel flaking. Cross-section is diamond-shaped. The shoulder is distinct but not barbed. The notches are broad shallow indentations with grinding. The base is broken, the remaining fragment suggests it was convex and ground. It was greater than 40 mm long and is 16 mm wide, 6 mm thick. The haft length was probably just over 12 mm, and basal width is 16 mm.

None of these points may be identified to any known type, nor do they resemble any other specimen in the Truman collections. All were collected during survey, #1, 2, and 4 from the surface, #3 at shallow depth in a shovel test hole.

Basal-Notched Points

Category 326 – SMITH – n = 10 (Plate 4a-d)

Basic description:

Blade: extremely long triangular blade with straight edges

Shoulders: extremely long barbs which are rounded at the base and whose lateral margins contract

somewhat making the widest part of the blade distal to the notches; barbs reach to base of the point

Notches: deep narrow elliptical notches inserted from the base at approximately 15° to 25°

Stem: narrow, very slightly expanding with straight outline

Base: straight and thin with angular corners; one specimen has basal and lateral grinding

Size:

Length: none are intact

Width: 38 to 53 mm ($\overline{X}$ = 45.4, s = 6.4, n = 5)

Thickness: 5 to 14 mm ($\overline{X}$ = 9.5, s = 3.0, n = 10)

Haft length: 10 to 19 mm ($\overline{X}$ = 14.2, s = 2.9, n = 9)

Basal width: 13 to 23 mm ($\overline{X}$ = 20.0, s = 4.1, n = 5)

Temporal and spatial distribution and references:

Smith points are considered by Chapman (1975: 286) to be Late Archaic. At Rodgers Shelter, they occur in lower Stratum 4 and are assigned to the Late Archaic (Kay 1978: 56). However, Smith points have been recovered from Middle Archaic assemblages in at least three sites: Tick Creek Cave (McMillan 1965: 73), Graham Cave (Klippel 1971) and the Coffey Site (O'Brien, et al. 1973, Schmits 1976: 17).

At one open site in the Truman Reservoir (23HI297) Smith points are clearly associated with Late Archaic forms such as Etley, Sedalia, and Table Rock Stemmed. That component was distinct from, but just below, a stratum containing Afton points. The results of thermoluminescence dating of these components are somewhat unclear. It appears that the component containing the Sedalia, Etley, and Smith forms may date at approximately 425 B.C. (Appendix B, Vol. I).

Two other Smith specimens were recovered during excavations at 23BE676. One, which was out of context, was dated by thermoluminescence techniques to 5854 B.C.±697. That date as well as the five other T.L. dates from the site appear unreasonably early (Appendix B, Vol. I).

Categories 327A and 328B — TRUMAN BROADBLADE — n = 33 (Plate 4f-p)

Points in this class have not previously been named. Given their ubiquity in southwest Missouri collections and fairly good stratigraphic placement at Rodgers Shelter (Kay 1978: 57-58), they are here named. There appear to be two variants of the form: Categories 327 and 328. The distinction between them is mainly in the width of the barb. Those designated here as Truman Broadblade A have wider barbs, which contribute to the extreme breadth of those specimens.

Category 327 — TRUMAN BROADBLADE Variant A — n = 5 (Plate 4f-g, l, n)

Basic description:

Blade: extremely broad large blade with convex edges; well thinned

Shoulders: extremely broad barbs with rounded proximal ends; lateral margin forms a nearly continuous curve broken only by the notches, extending to the base of the point

Notches: long, narrow, parallel-side notches inserted from the base at an approximately 30° angle

Stem: moderately expanding with straight outline

Base: subconvex with rounded corners

Size:

Length: the one complete specimen is 71 mm

Width: none are complete

Thickness: 7 to 11 mm ($\overline{X}$ = 8.8, s = 1.6, n = 5)

Haft length: 11 to 16 mm ($\overline{X}$ = 12.8, s = 1.9, n = 5)

Basal width: 24 to 28 mm ($\overline{X}$ = 25.7, s = 2.1, n = 3)

Temporal position and references:

This variant of the Truman Broadblade compares most favorably in form to Kay's Category 31 at Rodgers Shelter (1978: 57-58) which has been assigned to the Woodland period. No specimens of this variant have been excavated from open sites in Truman Reservoir. However, they tend to occur on

the surface or in the plow zone at sites where Variant B specimens have been excavated from Late Archaic and Woodland period assemblages.

Category 328 — TRUMAN BROADBLADE Variant B — n = 28 (Plate 4h-k, m, o-p)

Basic description:

Blade: moderate sized broad blade with convex edges, usually well thinned

Shoulders: long barbs, extending almost to the base of the point; proximal end of the barbs tapers more rapidly than do those in Category 327, coming to a rounded point; the lateral margin of the barbs forms a continuous curve with the base broken only by the notches

Stem: moderately expanding with straight outline; one specimen has grinding on the lateral margins

Notches: deep, narrow, parallel-sided notches inserted from very near the base at an angle approximately 30° to 40°

Base: convex with rounded corners

Size:

Length: two complete specimens measure 66 and 71 mm

Width: 43 to 52 mm ($\overline{X}$ = 46.7, s = 3.7, n = 6)

Thickness: 5 to 10 mm ($\overline{X}$ = 7.6, s = 1.2, n = 28)

Haft length: 11 to 18 mm ($\overline{X}$ = 13.4, s = 1.8, n = 24)

Basal width: 19 to 34 mm ($\overline{X}$ = 26.1, s = 3.9, n = 16)

Temporal position:

Specimens designated here as Truman Broadblade Variant B are generally of the same form as Variant A, with narrower barbs. This variant appears before the Woodland period in at least one site — 23HI297. There a Category 328 specimen was T.L. dated at 949 B.C.±266 (Appendix B, Vol. I). Another specimen at 23BE660 was recovered from a component which included Sedalia forms and probably also dates to the Late Archaic period. The variant continues into the Woodland period as evidenced by occurrences at three sites. A second specimen from 23HI297 was directly T.L. dated at A.D. 236±167.

Three specimens from 23BE337 can be dated indirectly between A.D. 510 and A.D. 1000 (Appendix B, Vol. I). Specimens occurred also at 23BE660 in the Woodland assemblage. This variant may be a more generalized form of those specimens classified by Kay (1978: 57-58) as Category 31, and may have come into use before the broader Variant A.

Category 329 – basal notched – n = 2 (Plate 4e)

Basic description:

Blade: approximately triangular, but poorly manufactured; excurvate lateral margins, cross-section is plano-trianguloid

Shoulders: distinct and reasonably broad, with short but wide barbs

Notches: corner removed

Haft: short and narrow in relation to total point size, straight sides

Base: both specimens exhibit some damage, but appear to be slightly convex

Size:

Length: the single intact specimen is 85 mm

Width: the same specimen is 37 mm wide

Thickness: 15 and 16 mm

Haft length: both are 15 mm

Basal width: neither basal width is intact

Comments and temporal position:

Unknown. Both of the present specimens are from surface context – one from 23BE337, a large multicomponent site; the other is from the surface of site 23BE802, a site that has otherwise yielded contracting stemmed and corner notched forms.

Straight-Stemmed Points

Category 336 – medium sized, short, straight stemmed darts – n = 19 (Plate 5a-d)

Basic description:

Blade: usually narrow, triangular blade with convex to straight edges; thin and often well flaked; two specimens have beveled blades

Shoulders: angular shoulders

Notches: rectangular shaped notches resulting in the square shoulders and straight stem

Stem: short, narrow straight or slightly expanding; one is laterally ground

Base: straight with rounded corners; one has basal grinding

Size:

Length: 51 to 81 mm ($\overline{X}$ = 66.7, s = 10.8, n = 6)

Width: 20 to 37 mm ($\overline{X}$ = 27.7, s = 5.2, n = 16)

Thickness: 6 to 10 mm ($\overline{X}$ = 7.2, s = 1.3, n = 19)

Haft length: 10 to 18 mm ($\overline{X}$ = 13.3, s = 2.2, n = 15)

Basal width: 13 to 19 mm ($\overline{X}$ = 16.6, s = 2.1, n = 14)

Comments and temporal position:

These specimens compare favorably in form to Kay's (1978: 49) Category 44 points. At Rodgers Shelter they occur in a Late Archaic context. A similar context is indicated at open sites in the Truman Reservoir. At 23HI297 they occur with forms such as Table Rock Stemmed and Etley, and Sedalia in a component which is tentatively dated at 425 B.C.$\pm$250 (Appendix B, Vol. I). At 23BE676 one specimen occurs with another straight stemmed form (Category 338) and Smith points.

Category 337 — STONE SQUARE STEM — n = 14 (Plate 4q-r, 5d-e)

Basic description:

Blade: thick triangular blade with irregularly flaked straight edges

Shoulders: prominent straight shoulders

Notches: rectangular notches creating the straight shoulders and straight stem

Stem: wide, long and nearly straight with a very gentle constriction very near the base; one has lateral grinding

Base: straight with rounded corners; one is basally ground

Size:

Length: the single intact specimen is 76 mm

Width: 23 to 36 mm ($\overline{X}$ = 29.7, s = 4.4, n = 10)

Thickness: 6 to 12 mm ($\overline{X}$ = 9.1, s = 1.2, n = 14)

Haft length: 16 to 23 mm ($\overline{X}$ = 18.7, s = 2.6, n = 14)

Basal width: 13 to 22 mm ($\overline{X}$ = 17.8, s = 2.3, n = 13)

Temporal position and references:

Chapman (1975: 257) has assigned Stone Square Stem to the Late Archaic period. At Rodgers Shelter (Kay 1978: 49) they occur in both Late Archaic and Woodland horizons. Only one specimen has been recovered from excavations at open sites in Truman Reservoir. At 23HI297 one specimen occurs slightly below a Late Archaic component which contained forms such as Table Rock Stemmed and Etley. The stratigraphic level in which the Stone Square Stem was found has been dated by thermoluminescence at 4000 B.C.$\pm$440, placing it very early in the Late Archaic period.

Category 338 – straight stemmed, angular shouldered and based dart – n - 8 (Plate 5f-g)

Basic description:

Blade: long, narrow triangular blade with straight edges

Shoulders: prominent square shoulders

Notches: rectangular squared notches producing the square shoulders and straight stem

Stem: short, wide, very slightly expanding with straight outline; one specimen has lateral grinding

Base: subconcave with angular corners; two have ground bases

Size:

Length: 63 to 80 mm ($\overline{X}$ = 71.5, s = 12.0, n = 2)

Width: 28 to 34 mm ($\overline{X}$ = 31.2, s = 2.6, n = 5)

Thickness: 7 to 10 mm ($\overline{X}$ = 8.4, s = 1.3, n = 8)

Haft length: 12 to 16 mm ($\overline{X}$ = 13.2, s = 1.4, n = 8)

Basal width: 19 to 26 mm ($\overline{X}$ = 21.3, s = 2.4, n = 6)

Comments and temporal position:

These specimens are similar in form to other straight stemmed points, but are more angular and well flaked. Only two specimens have been recovered from excavations of open sites in Truman Reservoir. At both 23BE337 and 23BE676 they occur in the earliest occupations. At 23BE676 the specimen from this category is found in association with a Category 336 point, a Smith point, and several Standlee points. From this stratigraphic evidence as well as the temporal placement of Category 336 points at Rodgers Shelter (Kay's Category 44) (Kay 1978: 49), these points are assigned to the Late Archaic. Two thermoluminescence dates from 23BE337 support this assignment; dates of 3305 B.C.±500 and 3417 B.C.±437 were obtained from an excavation level immediately above a Category 338 specimen (Appendix B, Vol. I).

Category 339 — ETLEY Variant A — n = 51 (Plate 5h-s)

Basic description:

Blade: thick, broad, triangular blade with straight edges; two are beveled

Shoulders: angular with moderate barbs

Notches: broad, fairly shallow, hyperbolic notches inserted at approximately a 30° angle

Stem: somewhat irregular, broad straight stem with straight outline; one has lateral grinding

Base: straight to subconvex with rounded corners; one specimen exhibits basal grinding

Size:

Length: 54 to 94 mm ($\overline{X}$ = 77.7, s = 14.8, n = 6)

Width: 31 to 52 mm ($\overline{X}$ = 40.2, s = 5.0, n = 30)

Thickness: 7 to 14 mm ($\overline{X}$ = 10.1, s = 1.4, n = 51)

Haft length: 11 to 21 mm ($\overline{X}$ = 16.2, s = 2.4, n = 45)

Basal width: 17 to 29 mm ($\overline{X}$ = 22.5, s = 3.2, n = 34)

Comments:

See Category 341.

Category 341 — ETLEY Variant B — n = 5 (Plate 5t-u)

Basic description:

Blade: long, thin, blade, with recurvate edges coming to a sharp tip

Shoulders: long wide barbs whose lateral margins flare, forming the widest part of the blade

Notches: narrow, deep, elliptical notches with parallel sides; inserted from the base at approximately 15^{o}

Stem: slightly expanding wide stem with straight outline

Base: subconvex with squared corners

All portions of the point are extremely well-flaked and thinned. This, as well as the extreme barb and notch length, distinguishes this from Variant A.

Size:

Length: the one intact length is 100 mm

Width: 43 to 46 mm ($\overline{X}$ = 44.5, s = 2-1, n = 2)

Thickness: 8 to 11 mm ($\overline{X}$ = 9.0, s = 2.0, n = 5)

Haft length: 14 to 16 mm ($\overline{X}$ = 15.0, s = 1.0, n = 3)

Basal width: 25 to 30 mm ($\overline{X}$ = 26.7, s = 2.9, n = 3)

Temporal and spatial distribution and references:

Etley points, named by Scully (1951: 2) are prevalent at mortuary sites (Titterington 1950, Roper 1978: 17) and habitation sites (Klippel 1969, Cook 1976) in Illinois and northeast Missouri. A single radiocarbon date from the Koster Site in Illinois (3950±75 B.P. [Cook 1976: 65]) places them in the Late Archaic period.

The only excavated site in the Truman Reservoir with reported Etley points is Rodgers Shelter, where they occur in Stratum 4 (Kay 1978: 66). Several specimens were recovered during the Stage I and II surveys (Roper and Piontkowski 1979). Further survey and excavations in the Truman

area have shown Etley points to be a rather ubiquitous type in southwest Missouri. The excavated specimens occur in the Late Archaic components at 23HI297, an open site. There appears to be no temporal difference between Variant A points and the more classic, well-made, Variant B specimens at that site. One specimen of each variant was recovered from a stratigraphic unit dated tentatively at 425±250 B.C. Another Variant A specimen was recovered in a different area of that site in a much deeper, but undated context.

Category 342 – TABLE ROCK STEMMED – n = 15 (Plate 6i-l)

Basic description:

Blade: convex edges triangular outline with fairly thick biconvex cross-section

Shoulders: strong rounded shoulders with concave outline

Notches: very large rounded corner notches producing a "bottle-neck" stem

Stem: slightly expanding with concave outline; four specimens have grinding on the lateral margins

Base: straight with angular corners; three are basally ground

Size:

Length: 24 to 47 mm ($\overline{X}$ = 34.0, s = 11.8, n = 3)

Width: 18 to 25 mm ($\overline{X}$ = 22.7, s = 2.2, n = 9)

Thickness: 5 to 9 mm ($\overline{X}$ = 6.5, s = 1.1, n = 15)

Haft length: 10 to 15 mm ($\overline{X}$ = 12.6, s = 1.4, n = 12)

Basal width: 11 to 18 mm ($\overline{X}$ = 14.4, s = 2.4, n = 13)

Temporal and spatial distribution and references:

Bray (1956: 127) and Perino (1968: 96) have both described Table Rock Stemmed points. They occur throughout the Ozarks and much of the Midwest (where they are called "bottle-neck" points [Perino 1968: 96]). Bray attributes them to a Middle Archaic period, but Perino dates them to about 1500 B.C., or just below early Afton levels. McHugh (1963: 45-6) states that in Oklahoma they may persist through Delaware B times and decrease in size through time.

In the Truman Reservoir area, Table Rock Stemmed points occur at Rodgers Shelter, where they date to the Late Archaic, and possibly the Woodland period (Kay 1978: 34). In an open site, 23HI297, the type occurs in two separate components.

One specimen is associated with Late Archaic forms such as Sedalia, Etley, and Smith, but it is tentatively dated into the Woodland period at 425±250 B.C. (Appendix B, Vol. I). Another occurs somewhat deeper and is probably associated with the component dated at 949±266 B.C.

The occurrence of Table Rock Stemmed points in two burial tumuli (Goldberg, Vol. III) shows that the form persisted into the Mississippian period. A specimen from 23CE122 produced a thermoluminescence date of A.D. 1400±50 (Appendix B, Vol. I).

Category 355 – small haft, straight stemmed – n = 16 (Plate 6a-f)

Basic description:

Blade: leaf-shaped with excurvate lateral margins often formed by relatively fine pressure flaking

Shoulders: distinct with a short barb

Notches: corner removed, with rounded distal end, set at right angles to the long axis of the point

Haft: straight stemmed, often, but not always, longer than broad, but always small in relation to total size of point

Base: convex

Size:

Length: 47 to 77 mm ($\overline{X}$ = 63.0, s = 15.1, n = 3)

Width: 28 to 38 mm ($\overline{X}$ = 32.9, s = 3.4, n = 13)

Thickness: 7 to 11 mm ($\overline{X}$ = 8.9, s= 1.2, n = 14)

Haft length: 12 to 18 mm ($\overline{X}$ = 15.0, s = 2.2, n = 13)

Basal width: 11 to 20 mm ($\overline{X}$ = 15.3, s = 3.7, n = 9)

Comments and temporal position:

Six of the specimens are from 23SR675, in a buried context (Hanson and Goldberg, Vol. I). A thermoluminescence

determination made on chert from a living surface where two Category 355 points were recovered resulted in a date of 2222±391 B.C., placing the form in the Late Archaic period.

Category 366 — short wide, stubby square based dart —

Basic description:

Blade: short, wide, straight to excurvate

Shoulders: strong, angular

Notches: round, broad U-shaped

Stem: extremely short

Base: straight with rounded corners

Size:

Length: both are incomplete

Width: 38 to 39 mm ($\overline{X}$ = 38.5, s = .7, n = 2)

Thickness: 6 to 10 mm ($\overline{X}$ = 8.0, s = 2.8, n = 2)

Haft length: the one complete specimen is 9 mm

Basal width: both incomplete

Temporal position:

The two specimens in this category compare favorably to those in Category 16 at Rodgers Shelter (Kay 1978: 36). There they are found in Late Archaic/Woodland context. The one specimen from excavated context in an open site, 23HI297, is in a Late Archaic assemblage, with Sedalia, Etley, Smith and Table Rock Stemmed points. The stratigraphic unit in which they occur has been tentatively dated at 425±250 B.C., the Woodland period (Appendix B, Vol. I).

Category 362 — Miscellaneous straight stemmed — n = 4

1. Only the haft element and a portion of one lateral margin remain of this once large specimen (Plate 6g). The lateral margins appear to have been excurvate. The shoulders are angular with a short barb. The haft element is broken but over 16 mm wide.

2. The lateral margins of this specimen are excurvate with fine flaking along all edges (Pl. 6h). The shoulders are narrow and have narrow barbs. The notches are elliptical and at a slight angle to the longitudinal axis of the point.

The haft therefore has nearly straight, but slightly diverging lateral margins. The base is broken but was probably nearly straight. Width = 31 mm, thickness = 6 mm, haft length = 17 mm.

3. The blade of this specimen was broken and has been reworked, leaving it with only one shoulder. Lateral margins are straight; the single shoulder is at almost a right angle and is narrow. The haft is considerably broader than it is long and has slightly expanding lateral margins. The base is straight. Width, as reworked = 36 mm, thickness = 7 mm, haft length = 16 mm, basal width = 30 mm.

4. This specimen has straight to convex lateral margins. The shoulders are narrow and were probably once barbed. The haft element is broken, but probably had expanding lateral margins. The base is totally destroyed. The 7 mm thickness is the only intact measurement.

Contracting Stem Points

Category 330 – GARY – n = 36 (Plate 7a-j)

Basic description:

Blade: triangular or ovate with either straight or convex edges; cross-section is thick and irregularly biconvex; one specimen is beveled

Shoulders: well defined, straight with rounded corners, joining the stem in a slightly rounded obtuse angle

Stem: varies from slightly to sharply contracting, with straight edges

Base: rounded to almost pointed; base grades smoothly into stem, with corners almost imperceptible; one specimen exhibits basal and lateral grinding

Size:

Length: 42 to 91 mm ($\overline{X}$ = 60.6, s = 16.0, n = 8)

Width: 26 to 44 mm ($\overline{X}$ = 34.5, s = 5.2, n = 24)

Thickness: 6 to 15 mm ($\overline{X}$ = 8.8, s = 2.4, n = 36)

Haft length: 16 to 27 mm ($\overline{X}$ = 21.2, s = 3.0, n = 34)

Basal width: 0 to 16 mm ($\overline{X}$ = 1.5, s = 4.3, n = 36)

Spatial and temporal distribution and references:

Gary points were originally named by Newell and Krieger (1949: 164-65) from specimens in Texas. They are widespread throughout the Midwestern United States.

The type appears in both Archaic and later contexts. They were the dominant form at the Flycatcher Site (23CE153) in the Stockton Reservoir area (Pangborn, Ward, and Wood 1967) and occur in the upper strata of Rodgers Shelter and Blackwell Cave (Falk 1969: 80). Falk suggests that the contracting stem forms probably date between A.D. 1 and A.D. 1000, but there are no radiocarbon dates to support this.

Purrington posits that Gary and Standlee points, although similar in form, represent different cultural traditions. While the Standlee forms were developed locally from earlier forms, Gary points in the Ozarks may be due to southwestern influence (Purrington 1971: 119). Such independence is supported by evidence in the Truman Reservoir area, where the two types occur together infrequently.

Purrington (1971) also posits that Standlee points are the first of the two types to appear in the Ozarks. Stratigraphic evidence from two sites in Truman supports that argument. Gary points were found in an excavated context at only one site, 23BE676. There they were within only the Late Woodland component. Standlee points, on the other hand, occurred earlier in a Late Archaic context and continued into the Woodland component. At another site, 23HI297, the Standlee points were found only in a Late Archaic component.

Category 332 – STANDLEE – n = 114 (Plate 7k-w)

Basic description:

Blade: triangular with straight or slightly convex edges; cross-section varies from thin to moderately thick biconvex; wide range in length-to-width ratio; ten specimens are beveled

Shoulders: some have well defined shoulders which are rounded, but angular; on these, the shoulder meets the stem in an obtuse, convex, angle; others have almost imperceptible shoulders; well rounded and grading into the stem

Stem: gradually tapering with straight or sub-convex outline

Base: straight or concave with angular or slightly rounded corner where the base meets the stem; one specimen has basal grinding

Size:

Length: 36 to 88 mm ($\bar{X}$ = 56.9, s = 11.4, n = 28)

Width: 24 to 48 mm ($\bar{X}$ = 33.2, s = 6.6, n = 73)

Thickness: 6 to 15 mm ($\bar{X}$ = 7.8, s = 1.5, n = 114)

Haft length: 11 to 32 mm ($\bar{X}$ = 19.8, s = 3.2, n = 105)

Basal width: 0 to 19 mm ($\bar{X}$ = 13.1, s = 3.2, n = 101)

Spatial and temporal distribution and references:

These Standlee points resemble the Langtry type from Texas, described by Suhm, Krieger and Jelks (1954: 438-9). In fact, points of the form similar to that of the points in this sample, which have been found in Oklahoma have been classified as Langtry (Baerreis, Freeman, Wright 1958). However, Scholtz (1967: 135-7) distinguished between the Oklahoma and Texas Langtry forms on the basis of thickness and a high frequency of convex-edged blades. Suhm and Krieger (1954: 438) also point out this regional variability. Both Scholtz and Marshall (1958: 120-1) therefore classify these Ozark "Langtry" points as Standlee.

Purrington (1971: 122) discusses the origins of the Standlee and Gary contracting stemmed forms and suggests that the two may have originated independently. He states that the Standlee points may have been a modified, later form of the early Hidden Valley and Searcy forms from the Ozarks, although there is an unexplainable temporal gap between the forms. The independence of Gary and Standlee seems to be supported from Truman Reservoir survey data; they tend to occur in separate sites, although they do co-occur.

In Oklahoma, Standlee tend to appear earlier than the Gary points (Purrington 1971: 122) and may date to 2000 years ago (Bell 1958: 38). In southwest Missouri, they occur in Late Archaic and Woodland contexts. At the Cootie Site, 23BE676, where Standlee is the predominate dart form, there is a continuous distribution of the Standlee points, from the Late Archaic into the Late Woodland component. Their occurrence is most dominant in the Late Archaic component. In the Woodland component they co-existed with Gary points. An analysis of the spatial and stratigraphic distribution of various shoulder and blade forms shows that there is fairly random patterning. A similar pattern was found in the distribution of various sub-types in Oklahoma (Purrington 1971: 122).

Category 343 — **WAUBESA** — n = 2 (Plate 6s-t)

Basic description:

Blade: large and leaf-shaped with gracefully curving convex lateral margins formed by alternately applied fine pressure flaking and with a smoothly curving biconvex cross-section

Shoulders: narrow, but distinct, at a slightly obtuse angle to the long axis of the point

Haft: wide, with converging lateral margins that curve into the not very distinct base; the term "Beavertail" used by some collectors for such specimens is an accurate description of the haft

Base: barely distinguishable from the lateral margins, one specimen is slightly flattened, the other is convex

Size:

Length: the complete specimen is 111 mm long

Width: each is 37 mm wide

Thickness: 8 and 9 mm

Haft length: 24 and 26 mm

Temporal and spatial distribution and references:

Waubesa points were described by Ritzenthaler (1967: 27) and by Perino (1971: 98). Both suggest a broad distribution in the eastern U.S., and a Late Archaic through Middle Woodland age. No data are available to support or refute such a placement either in Truman specifically or Missouri in general.

Category 365 — TURKEY TAIL — n = 2 (Plate 6p)

Basic description:

Blade: both specimens are broken but probably originally had excurvate lateral margins

Shoulders: distinct

Notches: very small in proportion to overall size, rather poorly chipped and always from the flatter side of the specimen only

Haft: straight lateral margins, converging to a point

Base: none by definition

Size:

Length: unknown

Width: unknown

Thickness: 6 and 7 mm

Haft length: 28 and 30 mm

Basal width: 0 by definition

Temporal and spatial distribution and references:

Turkey Tails, sometimes called Fulton Turkey Tails, were described by Titterington (1950: 24) at the Elm Point Site near St. Charles, Missouri and were named by Scully (1951: 11). They are widely distributed in the Midwest and Northeast, occurring into Michigan (Fitting 1970: 84-86) and Wisconsin (Ritzenthaler 1967: 22-23), and as far east as central New York (Ritchie 1961: 23). Another specimen was recorded in Truman Reservoir during the Cultural Resources Survey. Turkey Tails often occur in mortuary context (e.g., Elm Point, Mo., Titterington 1950: 24) and several Michigan sites (Fitting 1970: 84-85). It is probable that these items functioned in some sort of trade, for the New York specimens are specifically described as having been manufactured from Harrison County, Indiana chert (Ritchie 1961: 23) and the Wisconsin specimens are similarly described as made of bluish-gray hornstone, a term commonly used for Harrison County chert (Ritzenthaler 1967: 23). All Truman specimens are, however, manufactured from local cherts. Turkey Tails are Late Archaic in age, although poorly dated. A single date of 3170±150 B.P. at the Andrews Site in Michigan (Fitting 1970: 84) may apply.

Category 331 – general contracting stem – n = 15 (Plate 6 m-o)

The majority of the specimens assigned to this category possess the same blade and shoulder characteristics of the Gary and Standlee types. While they have the distinctive contracting stem of those types, the base has been broken off of these specimens, making the distinction between rounded vs. straight or concave base impossible.

The other three specimens assigned to this class similarly have contracting stems with broken bases. However, they differ slightly from the typical Gary and Standlee points. Two have weakly barbed shoulders and the third has an extremely long basal element.

In an excavated context at the Cootie Site, 23BE676, these unclassified points co-occur with both of the other contracting stem forms. It is not unreasonable to assume, then, that these are indeed either Gary or Standlee specimens.

Size:

Length: none are complete

Width: 25 to 38 mm ($\overline{X}$ = 33.0, s = 4.4, n = 11)

Thickness: 5 to 12 mm ($\overline{X}$ = 7.6, s = 1.7, n = 15)

Haft length: two complete specimens measure 16 and 18 mm

Basal width: 0

Category 345 – unclassified contracting stemmed A – n = 6 (Plate 6q-r)

Basic description:

Blade: all are too broken to evaluate, fragments of one suggest excurvate lateral margins

Shoulders: indistinct, are essentially the point where the diverging lateral margins of the blade change direction to become the converging lateral margins of the haft

Haft: broad, with converging lateral margins that meet a still relatively broad base

Base: straight on 2 specimens, concave on the other form

Size:

Length: unknown

Width: two intact widths are 28 and 40 mm

Thickness: 7 to 11 mm ($\overline{X}$ = 8.8, s = 1.6, n = 6)

Haft length: two intact measurements are 29 and 35 mm

Basal width: 20 to 26 mm ($\overline{X}$ = 23.2, s = 2.3, n = 6)

Comments and temporal distribution:

Unknown; all specimens described here are from the surface.

Category 346 — unclassified contracting stemmed B — n = 3

Basic description:

Blade: triangular with straight lateral margins formed by coarse chipping

Shoulders: wide and sharp but not barbed

Haft: slightly contracting stem leading into the base in a nearly continuous curve, short

Base: convex

Size:

Length: the single intact specimen is 48 mm

Width: no width is intact

Thickness: two intact thicknesses are 6 and 11 mm

Haft length: two intact measurements are 10 and 14 mm

Basal width: two intact measurements are 10 and 12 mm

Comments and temporal distribution:

Unknown. Two specimens are from 23SR504 where they occur in a buried context in a stratified deposit (Tippitt, Vol. I).

Category 347 — unclassified contracting stemmed C — n = 1 (Plate 6u)

Basic description:

Blade: large and triangular; lateral margins are slightly incurvate, one appearing faintly recurvate; alternately beveled, producing a parallelogram cross-section

Shoulders: wide and at right angles to the long axis of the point, one shoulder has a sort of lobed appearance

Haft: relatively short and narrow, with slightly converging lateral margins

Base: straight and oblique to the longitudinal axis of the point

Size:

Length: 130 mm

Width: 57 mm

Thickness: 10 mm

Haft length: 28 mm

Basal width: 11 mm

Comments:

This specimen more or less is a vastly overgrown Langtry point and otherwise resembles nothing in either other Truman Reservoir collections or known reports.

Corner-Notched Points

Category 301 – small notched, concave-based – n = 5 (Plate 8a-b)

Basic description:

Blade: triangular with straight edges

Shoulders: small, but well defined; usually straight, but a few are slightly barbed

Notches: wide, shallow, almost hyperbolic, inserted at approximately 90°; two specimens have grinding

Stem: sharply expanding with concave outline

Base: concave with rounded corners; broader than wide at shoulders; two specimens have ground bases

Size:

Length: 28 to 35 mm ($\overline{X}$ = 32.0, s = 3.6, n = 3)

Width: two intact specimens measure 18 and 20 mm

Thickness: 5 to 6 mm ($\overline{X}$ = 5.8, s = .4, n = 5)

Haft length: 10 to 14 mm ($\overline{X}$ = 11.6, s = 1.5, n = 5)

Basal width: two intact widths are 17 and 20 mm

Temporal position:

These small dart points are similar to Kay's (1978: 35) Category 14. At Rodgers Shelter they are dated to the Late Archaic and Woodland periods. At open sites 23BE676 and 23BE337 they have been recovered only from Woodland components and co-occur with forms such as Rice-Side-Notched, Scallorn, and Fresno.

Category 302 – small corner-notched, concave-based – n = 17 (Plate 8c-e)

Basic description:

Blade: triangular with straight edges; one specimen is beveled

Shoulders: broad, strongly barbed

Notches: long, elliptical, parallel sided, inserted at approximately 40° to 60° angle

Stem: moderately to sharply expanding with straight to convex outline; only one specimen is ground

Base: concave with sharp, but rounded corners; only slightly narrower than width at shoulder; one specimen is ground

Thinner and better flaked than Category 301.

Size:

Length: no complete specimens

Width: 16 to 27 mm ($\overline{X}$ = 22.0, s = 5.6, n = 3)

Thickness: 4 to 6 mm ($\overline{X}$ = 5.2, S = .7, n = 14)

Haft length: 7 to 13 mm ($\overline{X}$ = 10.3, s = 1.9, n = 14)

Basal width: 11 to 21 mm ($\overline{X}$ = 16.9, s = 3.5, n = 10)

Comments and temporal position:

Similar to several specimens at Rodgers Shelter in Kay's (1978: 35) Category 14, these are found in both Archaic and Woodland components at 23BE337 and 23HI297. Morphologically they are similar to points in Category 301, but are thinner. This difference, as well as the fact that they may appear in an earlier context, supports this tentative division into two classes.

At 23BE337 they occur in a stratigraphic unit which has been well dated; A.D. 620±110 and A.D. 634±109 at the bottom, and A.D. 904±97 and A.D. 854±91 at the top. At 23HI297 these points are found in two contexts. Two specimens were recovered within a Woodland assemblage which dates to A.D. 483±144 and A.D. 397±152. Another Category 302 point was found in a much deeper context, the dates of which are unclear but are probably no later than the 949±226 B.C. date obtained at that level (Appendix B, Vol. I).

Category 306 – small corner-notched, straight based – n = 10 (Plate 8f-g)

Basic description:

Blade: triangular with straight edges

Shoulders: strong with small barbs

Notches: parabolic, inserted at approximately 30° to 45°

Stem: slightly to moderately expanding with convex outline

Base: straight with angular or slightly rounded corners nearly the same width as shoulders

Size:

Length: 30 to 38 mm ($\overline{X}$ = 34.0, s = 4.1, n = 4)

Width: 16 to 23 mm ($\overline{X}$ = 20.4, s = 2.5, n = 7)

Thickness: 5 to 7 mm ($\overline{X}$ = 6.1, s = .7, n = 10)

Haft length: 9 to 12 mm ($\overline{X}$ = 10.2, s = 1.0, n = 9)

Basal width: 16 to 22 mm ($\overline{X}$ = 19.2, s = 2.7, n = 4)

Comments and temporal position:

In form, these small darts compare favorably to Kay's (1978: 35) Category 14, although several of these specimens are more corner-notched than side-notched. At Rodgers Shelter they have been assigned to a Late Archaic/Woodland period. Only one has been found in excavated context in an open site (23HI297). There it co-occurred with Etley, Sedalia, Table Rock Stemmed, and Smith points which may date as late as 425±250 B.C. (Appendix B, Vol. I).

Category 315 – small, narrow-corner-notched, barbed – n = 13 (Plate 8h-l)

Basic description:

Blade: triangular with straight edges; fairly thin

Shoulders: long, angular barbs

Notches: long, narrow, elliptical notches inserted at approximately a 45° angle

Stem: moderately expanding with straight outline; three specimens have grinding on the haft element

Base: subconcave with angular corners slightly narrower than shoulders; three are basally ground

Size:

Length: 37 to 53 mm ($\overline{X}$ = 43.7, s = 8.3, n = 3)

Width: the two intact widths are 29 and 30 mm

Thickness: 5 to 8 mm ($\overline{X}$ = 6.4, s = 1.0, n = 13)

Haft length: 9 to 14 mm ($\overline{X}$ = 11.5, s = 1.3, n = 13)

Basal width: 13 to 21 mm ($\overline{X}$ = 18.6, s = 2.5, n = 10)

Comments and temporal position:

Many of these specimens resemble Kay's (1978: 35) Category 14 points from Rodgers Shelter. There, they are assigned to the Late Archaic and Woodland periods. A similar temporal span is postulated for these points on the basis of their stratigraphic position in two loci at 23HI297, an open site. Thermoluminescence techniques yielded dates of A.D. 600 ± 150, A.D. 483 ± 144, and A.D. 397 ± 152 (Appendix B, Vol. I) from the assemblages in which Category 315 points were found.

Category 303 – small corner-nothced – n = 23 (Plate 8j-l)

Basic description:

Blade: triangular with convex edges; one specimen is beveled

Shoulders: strong angular shoulders

Notches: fairly broad U-shaped inserted at approximately 50° to 60°

Stem: moderately expanding with straight to slightly convex outline; six exhibit grinding on the haft element

Base: subconcave with rounded corners, narrower than shoulders; six specimens have ground bases

Very evenly flaked and well executed.

Size:

Length: 27 to 50 mm ($\overline{X}$ = 34.0, s = 6.8, n = 10)

Width: 18 to 46 mm ($\overline{X}$ = 22.5, s = 7.6, n = 12)

Thickness: 4 to 10 mm ($\overline{X}$ = 5.6, s = 1.1, n = 23)

Haft length: 8 to 26 mm ($\overline{X}$ = 10.7, s = 3.6, n = 22)

Basal width: 9 to 20 mm ($\overline{X}$ = 16.9, s = 3.5, n = 10)

Comments and temporal position:

These specimens are morphologically similar to Kay's (1978: 34) Category 13 at Rodgers Shelter. At the one open site where they were recovered from excavated context (23HI297) they have a temporal distribution confined to the Woodland period. At Rodgers Shelter it appears that the form may have been in use during the Late Archaic period.

Category 304 — corner-notched, short, sharply expanding based dart/arrow — n = 5 (Plate 8m-n)

Basic description:

Blade: triangular with slightly convex edges

Shoulders: strong with very short barbs

Notches: narrow, small, parabolic inserted at an angle of about 60° to 70°

Stem: very sharply expanding, creating a short base

Base: straight with rounded corners; as wide as shoulders

Size:

Length: 26 to 30 mm ($\overline{X}$ = 28.0, s = 2.0, n = 3)

Width: 17 mm ($\overline{X}$ = 17.0, s = 0.0, n = 3)

Thickness: 4 to 7 mm ($\overline{X}$ = 5.2, s = 1.1, n = 5)

Haft length: 6 to 8 mm ($\overline{X}$ = 7.0, s = .8, n = 4)

Basal width: the one complete specimen is 15 mm

Comments and temporal position:

These small projectiles are similar in form to Scallorn arrowpoints but are larger (perhaps small dart points). None have been described previously in the literature. Two were recovered from excavated contexts in the Truman Reservoir area, but cultural associations at one of the sites are unclear. The specimen at 23BE337 was found below a component which contained Afton and Truman Broad-Blade points. That component has been dated at A.D. 620±110 and A.D. 634±109 – the Woodland period. A date of 1374±282 B.C. was obtained from a component slightly below the Category 304 point. The other specimen was recovered at 23HI297 from an assemblage which has been dated at A.D. 483±144 and A.D. 397±152 (Appendix B, Vol. I).

Category 354 – RICE LOBED – n = 12 (Plate 8p-s)

Basic description:

Blade: triangular, with straight to excurvate lateral margins

Shoulders: distinct but unbarbed

Notches: rectangular corner removals

Haft: has slightly expanding lateral margins, and generally is wider than it is long

Base: very slightly convex to slightly concave; haft lateral margins and base meet in broad, well rounded corners that designate the point as lobed; only a single specimen has a ground base

Size:

Length: two intact specimens are 58 and 69 mm

Width: 33 to 48 mm ($\overline{X}$ = 39.3, s = 5.9, n = 6)

Thickness: 6 to 10 mm ($\overline{X}$ = 8.5, s = 1.5, n = 12)

Haft length: 11 to 22 mm ($\overline{X}$ = 15.9, s = 2.9, n = 10)

Basal width: 23 to 34 mm ($\overline{X}$ = 28.0, s = 3.6, n = 9)

Temporal and spatial distribution and references:

Rice Lobed points were named at the Rice Site in Stone County (Bray 1956). They are common throughout the Ozarks. Chapman (1975: 254) considers them to date between 9500 and 7000 years ago. They are common at Rodgers Shelter where they are scattered throughout Strata 1 and 2. Their modal occurrence, however, is in Horizon 9, estimated to date 9500-8600 years ago (Kay 1978).

C. Chapman (1975: 254) considers them to be similar to the large variety of Kirk Corner-Notched, named by Coe (1964: 69-70) on the North Carolina Piedmont, and widely distributed in the southeast. The Rodgers Shelter projected dates do in fact coincide nicely with the Kirk dates in the lower Little Tennessee River Valley (J. Chapman 1976: 3) suggesting that the Rice Lobed could represent a local variant of what Tuck (1974: 76) has described as the Kirk Horizon.

Category 305 – narrow-corner-notched, acuminate-bladed dart – n = 16

Basic description:

Blade: fairly broad with straight to acuminate edges

Shoulders: short to moderate rounded barbs, extending nearly to base

Notches: U-shaped, inserted near the base at approximately a 20° to 30° angle

Stem: extremely short, slightly expanding, with concave outline

Base: straight to subconvex with angular corners; much narrower than width at shoulders

Size:

Length: 42 to 73 mm ($\overline{X}$ = 62.8, s = 11.3, n = 6)

Width: 35 to 42 mm ($\overline{X}$ = 39.0, s = 2.8, n = 7)

Thickness: 6 to 10 mm ($\overline{X}$ = 7.2, s = 1.1, n = 16)

Haft length: 9 to 14 mm ($\overline{X}$ = 11.4, s = 1.8, n = 14)

Basal width: 14 to 30 mm ($\overline{X}$ = 22.6, s = 4.2, n = 12)

Temporal position:

These specimens are similar to Kay's (1978: 95) Category 47 at Rodgers Shelter. Only one of these came from an excavated context (23HI297), where it was within a Late Woodland assemblage with Rice Side-Notched, Reed, and Scallorn points.

Categories 307, 313, 316 – AFTON – n = 54 (Plate 9a-j)

Basic description:

Blade: ranges from fairly short to long, broad blade with irregular edges; of the specimens with intact blades, all exhibit angular lateral margins at about one-half to two-thirds the blade length converging there to the tip; two specimens are beveled

Shoulders: moderate to long barbs with fairly rounded tips; often broken and sometimes irregularly shaped

Notches: narrow elliptical, parallel-sided, inserted at 40^{o} to 60^{o} angle to medial axis

Stem: ranges from sharply to gently expanding, moderate in length with straight, sub-convex, or subconcave outline

Base: straight to subconvex with angular but rounded corners; base narrower than width at shoulders; one specimen has a ground base

Size:

Length: 35 to 59 mm ($\overline{X}$ = 45.7, s = 8.6, n = 7)

Width: 28 to 45 mm ($\overline{X}$ 34.9, s = 4.7, n = 22)

Thickness: 5 to 10 mm ($\overline{X}$ = 6.9, s = 1.0, n = 51)

Haft length: 9 to 16 mm ($\overline{X}$ = 12.0, s = 1.6, n = 52)

Basal width: 10 to 31 mm ($\overline{X}$ = 23.9, s = 4.0, n = 34)

Temporal and spatial distribution and references:

Although a sharply angular blade is a distinctive feature on many Afton points, not all specimens were assigned to this class on that basis. Most have blades which contract slightly about 1/2 or 2/3 of the way up the blade.

Wood (1960) has similarly classified points lacking this pentagonal blade, but possessing thin blades and certain characteristics of the notch, as Afton points.

Afton points occur throughout the western Ozark Highland. Wood (1960) states that they are found in great numbers only in ceremonial contexts. Survey and excavation in the Truman Reservoir area subsequent to 1960 has shown that although the more carefully thinned angular bladed Afton points do occur most frequently in the burial tumuli (particularly 23HI135, Holbert Bridge Mound [Wood 1961]), points of the same general form do occur in open and shelter sites, with some frequency (Roper and Piontkowski 1979). In southwest Missouri and Oklahoma (Purrington 1971: 132) Afton points appear stratigraphically in preceramic contexts. Kay (1978: 61) assigns the specimens from Rodgers Shelter to the Late Archaic period. An Afton point from the Holbert Bridge Mound, 23HI135, was dated at 900±427 B.C., and a tooth from the only burial from that mound similarly dated at 1045±201 B.C. (Appendix B, Vol. I). Those thermoluminescence determinations, placing the mound and its many Afton points in a Late Archaic context, are clearly different from two radiocarbon determinations made on the bone from the skeleton – A.D. 1565±105 and A.D. 1430±135 (Wood 1976: 311).

Further ambiguity about the temporal placement of the Afton form is introduced by stratigraphic occurrences and thermoluminescence dating at two open sites – 23BE337 and 23HI297. The base of an assemblage in which three Afton points occur at 23BE337 has been dated at A.D. 620±110 and A.D. 634±109, placing them firmly in the Woodland period. At 23HI297 three Afton points were recovered below a Late Woodland component containing Rice Side-Notched and several arrow forms. These points, however, were clearly above a component which contained Late Archaic styles such as Sedalia, Etley, and Smith points, but which tentatively dates to the Woodland period (425±250 B.C.). The Afton points may be represented by a date of A.D. 20±200 which was obtained on materials at the same level (see Appendix B, Vol. I).

Category 312 – Afton-like – n = 15 (Plate 9k-l)

Basic description:

Blade: fairly narrow, triangular with straight edges; one specimen is beveled

Shoulders: long angular barbs, often broken

Notches: long, narrow, parallel-sided, inserted at approximately 20^{o} to 30^{o} angle

Stem: extremely narrow (this attribute separates these points from Afton points), slightly expanding with straight outline

Base: nearly straight with angular corners

Size:

Length: no lengths are intact

Width: 29 to 32 mm ($\overline{X}$ = 30.8, s = 1.3, n = 5)

Thickness: 5 to 9 mm ($\overline{X}$ = 6.8, s = 1.1, n = 15)

Haft length: 11 to 17 mm ($\overline{X}$ = 12.7, s = 1.6, n = 14)

Basal width: 12 to 25 mm ($\overline{X}$ = 19.1, s = 3.1, n = 12)

Comments and temporal position:

These points share many formal characteristics of Afton points. However, none possess the angular blade margins typical of Aftons. Also, the stems of the specimens in this category are somewhat narrower. While none of these specimens came from excavated context, they often occur in surface collections from excavated sites where Afton points have been recovered. Thus, this type may similarly date to the Late Archaic period and be a variant of the Afton type.

Category 309 – medium, elliptical corner-notched – n = 26 (Plate 9m-o)

Basic description:

Blade: triangular with straight to convex edges; one specimen is beveled

Shoulders: moderate to strong barbs; pointed

Notches: deep, parabolic, inserted at approximately a 45^{o} to 60^{o} angle

Stem: narrow at notches, sharply expanding with straight to convex outline; three specimens have grinding on the haft element

Base: sub-concave with angular corners; slightly narrower than width at shoulder; four are basally ground

Size:

Length: 26 to 49 mm ($\overline{X}$ = 39.4, s = 7.9, n = 8)

Width: 22 to 33 mm ($\overline{X}$ = 27.1, s = 3.4, n = 15)

Thickness: 5 to 8 mm ($\overline{X}$ = 11.9, s = 1.4, n = 25)

Basal width: 14 to 25 mm ($\overline{X}$ = 18.2, s = 3.4, n = 16)

Comments and temporal position:

No specimens similar in form to these have been described previously in the literature. In size and basic outline they resemble other small dart forms from Truman Reservoir. However their notches are deeper and more symmetrical. They tend to co-occur with several other of the small dart forms and can probably be assigned to the Woodland period. They occur in stratigraphic units from 23BE337 and 23HI297 which have been dated to A.D. 620±110 and A.D. 483±144, respectively (Appendix B, Vol. I).

Category 310 — corner-notched with angular to barbed shoulders — n = 57 (Plate 10a-h)

Basic description:

Blade: variable length, fairly broad triangular blade with irregular convex edges; one specimen has an extra pair of notches near the base of the blade; one other specimen has beveled edges

Shoulders: strong shoulders with an occasional weak barb; rounded corners

Notches: moderately deep parabolic notches; irregularly shaped; inserted at approximately a 40° to 60° angle

Haft: moderately expanding; range from convex with heavy retouch to concave with no retouch; one specimen has lateral grinding

Base: convex with angular to rounded corners; nearly as wide as shoulders; one specimen has a ground base

Size:

Length: 37 to 71 mm ($\overline{X}$ = 52.8, s = 11.4, n = 12)

Width: 26 to 41 mm ($\overline{X}$ = 34.9, s = 3.8, n = 21)

Thickness: 6 to 12 mm ($\overline{X}$ = 8.1, s = 1.3, n = 57)

Haft length: 11 to 19 mm ($\overline{X}$ = 14.5, s = 1.7, n = 52)

Basal width: 19 to 32 mm ($\overline{X}$ = 26.2, s = 3.5, n = 35)

Temporal position and comments:

These points compare favorable to those identified by Purrington (1971: 98) as Cooper Variants A and D. These variants are separable from Purrington's other variants and from Category 311 on the basis of their angular and sometimes barbed shoulders. In Purrington's description of Cooper points, he cautions against confusing them with Williams points. The Williams form is generally more massive and is retouched on the proximal portion of the stem, thereby modifying the notch to a convex outline. Specimens placed here in Category 310 range from unretouched to heavily retouched. No true line of demarcation exists, however, one form grades into the other. To separate the specimens into two categories would be unrealistic.

Such lumping necessitates caution when assigning a temporal designation to this category. Cooper points in northeastern Oklahoma are attributed largely to a cultural unit intrusion during the Woodland period (Purrington 1971: 98). They are similar in form to points associated with Kansas City Hopewell (Shippee 1967). However, Purrington states that the Cooper form may have preceded this post-Middle Woodland intrusion (1971: 103).

Williams points, on the other hand, appear to be an earlier form, appearing during the Middle Archaic period and perhaps continuing past the Late Archaic period. Purrington cautions that since the Williams is such a generalized form of corner-notched point, temporal assignments are tenuous (Purrington 1971: 145).

Kay (1978: 82) has assigned points similar in form to these to his Category 48. At Rodgers Shelter, they occur in the Late Archaic and Woodland strata. Only one point from this category was found in an excavated open site in Truman Reservoir. At 23BE337, this point occurs in a Late Archaic component. It appears that there may have been a tradition of corner-notched points in the region, beginning in the Middle Archaic and continuing into the Woodland period, but the fact that 56 of the specimens in this category were recovered from the surface does little to support or disconfirm such an hypothesis.

Category 311 – shallow corner- to side-notched – n = 41 (Plate 10l-p)

Basic description:

Blade: triangular broad blade with convex edges; seven specimens have beveled blades; one blade has been reworked into a scraper and another into a drill

Shoulders: strong but rounded

Notches: broad, shallow, parabolic notches inserted at approximately a 70^{o} to 90^{o} angle to the long axis — a less acute angle than that on points in Category 310

Stem: broad, moderately expanding with a concave outline; three are ground

Base: subconvex with rounded angular corners; nearly as wide as the shoulders; three have basal grinding

Size:

Length: 32 to 66 mm ($\overline{X}$ = 48.1, s = 9.7, n = 16)

Width: 24 to 41 mm ($\overline{X}$ = 31.1, s = 4.4, n = 26)

Thickness: 6 to 12 mm ($\overline{X}$ = 7.9, s = 1.4, n = 41)

Haft length: 12 to 19 mm ($\overline{X}$ = 15.2, s = 1.8, n = 38)

Basal width: 22 to 32 mm ($\overline{X}$ = 26.0, s = 2.7, n = 30)

Comments and temporal position:

These specimens are similar in form to those in Category 310, but the notches are inserted more near at a 90^{o} angle thereby creating a nearly side-notched form. They compare favorably with Purrington's Cooper Variant C (Purrington 1971: 100). Many are also similar to points classified by Kay (1978: 122) at Rodgers Shelter as Category 55. Additionally, several specimens have only a slightly more prominent shoulder than Rice Side-Notched points.

Cooper points in northeastern Oklahoma are generally assignable to the Woodland period but occasionally precede a site unit intrusion of Cooper Focus peoples to the area (Purrington 1971: 103). Kay (1978: 122) suggests that this form persisted from the Middle Archaic until the Woodland period in southwest Missouri. At that site, three specimens were recovered; one was from the Late Archaic component, dating at 949±266 B.C., the others were from Woodland period components. Many points of this form were recovered from burial tumuli in the area. They often co-occurred there with Rice Side-Notched points, a form to which they are morphologically similar (see Goldberg, Vol. III, Pt. 1) for discussion. A specimen from 23BE6 (Mound 1) was dated at A.D. 1060±45 (Appendix B, Vol. I) showing the persistence of this form late into the Woodland period.

Category 317 — SNYDERS — n = 20 (Plate 10q-t)

Basic description:

Blade: large, very broad blade with convex edges

Shoulders: broad, pointed, moderate barbs

Notches: deep, broad, parabolic notches inserted at approximately a 40^{o} to 50^{o} angle

Stem: fairly narrow, slightly expanding with convex outline

Base: subconvex with rounded angular corners; much narrower than wide at the shoulders

Size:

Length: 53 to 72 mm ($\overline{X}$ = 63.2, s = 7.0, n = 5)

Width: 36 to 51 mm ($\overline{X}$ = 42.1, s = 4.8, n = 13)

Thickness: 7 to 11 mm ($\overline{X}$ = 8.8, s = 1.1, n = 20)

Haft length: 12 to 19 mm ($\overline{X}$ = 15.4, s = 1.8, n = 20)

Basal width: 22 to 34 mm ($\overline{X}$ = 27.0, s = 3.0, n = 14)

Temporal position:

Snyders points are prevalent in Illinois Hopewell components and are a horizon marker for the Middle Woodland period (White 1965). They are fairly common in Kansas City Hopewell sites which may somewhat post-date the Hopewell occupations in Illinois. In Missouri (Kay 1975) and Oklahoma (Purrington 1971: 98-110) similar forms are associated with Middle Woodland ceramics. In southwest Missouri burial tumuli, an occasional Snyders point is found sometimes associated with other Hopewellian artifacts — e.g., cut wolf maxillae and a mammiform object (Wood 1967). In the tumuli, they probably post-date Middle Woodland horizons in Illinois (Goldberg, Vol. III, Pt. 1). The only specimen recovered in situ from an open site was from 23BE676 where it was associated with Middle Woodland pottery in a feature which was within a primarily Gary component.

Category 314 — expanding stem — n = 11 (Plate 9p-q)

Basic description:

Blade: triangular with straight to very slightly excurvate lateral margins, except for one specimen that has been reworked to a drill

Shoulders: distinct, with short barbs, shoulders are not broad

Notches: corner removed

Haft: expanding stemmed, expanding to a base not quite as broad as the shoulders

Base: straight to slightly convex

Size:

Length: a single intact specimen is 28 mm long, but is probably unrepresentatively short

Width: 28 to 34 mm ($\overline{X}$ = 30.3, s = 3.2, n = 3)

Thickness: 6 to 9 mm ($\overline{X}$ = 7.2, s = 1.3, n = 11)

Haft length: 12 to 17 mm ($\overline{X}$ = 13.7, s = 2.1, n = 11)

Basal width: 15 to 29 mm ($\overline{X}$ = 24.1, s = 3.8, n = 9)

Comments and temporal position:

These specimens could not be compared to anything in the literature. All but one occurred in surface context; the final specimen was excavated from a shallow site (23BE214). Four of the surface specimens were collected from 23SR189, a large multicomponent site with a large diversity of projectile point types present; two were from 23BE681 which is primarily Woodland (Tippitt, Vol. I).

Category 356 — narrow, deep notches — n = 2 (Plate 8o)

Basic description:

Blade: triangular with straight to slightly concave lateral margins

Shoulders: broad with long wide barbs that extend about 3/4 or more of the length of the haft

Notches: narrow and very deep with nearly parallel sides

Haft: short, with rapidly expanding straight lateral margins that terminate in a base not quite as wide as the shoulders

Base: very slightly concave

Size:

Length: one intact length is 45 mm

Width: one intact width is 30 mm

Thickness: each is 6 mm thick

Haft length: each haft is 9 mm long

Basal width: each base is 19 mm wide

Comments and temporal position:

Unknown. Both specimens are from surface context.

Category 357 – CUPP – n = 1 (Plate 10u)

Basic description:

Blade: triangular with a straight lateral margin on one side, but impact fracturing making determination impossible on the other

Shoulders: distinct, one is barbed, the other probably was but has been broken and reworked

Notches: long and elliptical, set at an acute angle to the long axis of the point

Haft: relatively long due to the length of the notches; lateral margins are incurved and flare rapidly to the corner of the point

Base: slightly convex

Size:

Length: not intact but originally around 80 mm

Width: 33 mm

Thickness: 8 mm

Haft length: 18 mm

Basal width: 33 mm

Temporal and spatial distribution and references:

Cupp points, as defined by Perino (1971: 20), are similar to Motley points as defined by Bell (1958: 62). These latter are widespread but never occur in large numbers.

A single specimen occurred in Stratum 4 at Rodgers Shelter (Kay 1978: 120-21) and 5 were collected during the Cultural Resources Survey. Kay (1978: 121) considers them Late Archaic or Woodland. Winters (1967: 92) regards Motley as Early Woodland in the Wabash Valley of Illinois, with a provisional date of 1500-500 B.C. The single specimen reported by Purrington (1971: 183) seems to be in an equivalent position. Cupp points do occur, however, in a few of the Fristoe mounds which are interpreted as Late Woodland and Mississippian (Goldberg 1980: 62) and in the Neosho Focus a late prehistoric manifestation in northeast Oklahoma (Freeman 1959). Chapman (1980: 308), however, considers them Late Woodland-Mississippian and restricted to the Southwest Drainage-Western Prairie areas of Missouri, Kansas, Arkansas, and Oklahoma.

Category 359 — eared, stemmed points — n = 13 (Plate 9s-u)

Basic description:

Blade: lateral margins range from straight to more frequently excurvate; several specimens show well executed regular pressure flaking along the edges

Shoulders: distinct, usually barbed

Notches: essentially elliptical, at an angle not quite parallel to the long axis of the point

Haft: lateral margins expand slightly to a base that is narrower than the shoulders of the point; haft is relatively short

Base: slightly convex to slightly concave; the base-lateral margin of the haft juncture has laterally projecting ears on several specimens

Size:

Length: 46 to 63 mm ($\overline{X}$ = 51.8, s = 7.7, n = 4)

Width: 28 to 35 mm ($\overline{X}$ = 31.6, s = 2.4, n = 7)

Thickness: 6 to 9 mm ($\overline{X}$ = 7.3, s = .9, n = 12)

Haft length: 11 to 15 mm ($\overline{X}$ = 12.8, s = 1.5, n = 13)

Basal width: 19 to 29 mm ($\overline{X}$ = 23.5, s = 3.0, n = 10)

Comments and temporal position:

Unknown. A single specimen was excavated at 23BE337 from a level that suggests it probably is from the Woodland

period. It was found in the lower portion of a component which was dated at A.D. 620±110 and A.D. 634±109 (Appendix B, Vol. I) and which contained Afton-like points (Category 316).

Category 360 – crude, square notched – n = 9 (Plate 8u-v)

Basic description:

Blade: triangular with excurvate lateral margins

Shoulders: narrow but distinct with short barbs on most specimens

Notches: semi-circular to elliptical corner, set at an angle to the long axis

Haft: expanding stemmed and usually relatively short

Base: convex and only slightly narrower than the shoulders

Size:

Length: only a single intact length is 27 mm

Width: 31 to 35 mm ($\overline{X}$ = 32.7, s = 2.1, n = 3)

Thickness: 6 to 11 mm ($\overline{X}$ = 7.8, s = 1.6, n = 9)

Haft length: 11 to 16 mm ($\overline{X}$ = 12.6, s = 1.7, n = 8)

Basal width: 13 to 25 mm ($\overline{X}$ = 20.3, s = 5.1, n = 4)

Comments and temporal position:

Unknown. All specimens are from surface context, mostly from large multicomponent sites with materials of all ages.

Category 363 – bulbous haft, barbed – n = 4 (Plate 8w-x)

Basic description:

Blade: highly excurvate lateral margins

Shoulders: barbs extend to about 1/2 the length of the haft

Notches: deep and parabolic corner notches at an angle to the long axis of the specimen

Haft: slightly expanding lateral margins expanding to a base that is slightly wider than the haft is long in most instances

Base: convex with rounded corners

Size:

Length: a single intact length is 49 mm

Width: two intact widths are 34 and 36 mm

Thickness: 6 to 11 mm ($\overline{X}$ = 8.5, s = 2.4, n = 4)

Haft length: 13 to 17 mm ($\overline{X}$ = 14.5, s = 1.9, n = 4)

Basal width: 18 to 23 mm ($\overline{X}$ = 20.3, s = 2.5, n = 3)

Comments and temporal position:

Unknown. All specimens are from surface context.

Category 367 — large angular blade — n = 2 (Plate 8y)

Basic description:

Blade: large with highly excurvate lateral margins that recurve slightly at the proximal end

Shoulders: proportionally narrow with short wide barbs

Notches: small and ovoid corner notches set at an angle to the longitudinal axis of the point

Haft: short, with expanding lateral margins

Base: slightly convex

Size:

Length: the complete specimen is 79 mm long

Width: the same specimen is 49 mm wide

Thickness: 8 and 9 mm

Haft length: both are 12 mm long

Basal width: 24 and 28 mm

Comments and temporal position:

Unknown. Both specimens are from surface context.

Category 364 — Unclassifiable corner notched — n = 75

This is a residual category, containing broken specimens that are projectile points and retain enough of the haft to

allow their identification as corner-notched points. They are, however, otherwise sufficiently damaged and broken in such a manner as to make it impossible to determine which corner-notched category they best fit.

Category 999 — Unclassifiable projectile point fragments — n = 62

These specimens are sufficiently damaged that it is impossible to determine even a general morphological class, such as corner-notched, side-notched, etc., although most fragments can be determined to be broken projectile points. A possibility remains that more such specimens are within the materials described by regular lithics procedures.

Arrows

Category 322 — SCALLORN — n = 48 (Plate 11a-n)

Basic description:

Blade: triangular with straight or slightly convex edges; thin bi-convex cross-section; approximately one-fourth have serrated edges; degree of serration ranges from almost none (possibly flake scars from pressure retouch) to well-formed, precise and even nodes

Shoulders: range from nearly straight to heavily barbed; angular with straight outline

Notches: broad to medium U-shaped, inserted at 30° to 60° angle to the medial axis

Stem: moderately to very sharply expanding with concave outline

Base: ranges from subconcave to extremely convex; corners usually angular but in convex based specimens, the corners are rounded

Size:

Length: 17 to 39 mm ($\overline{X}$ = 25.0, s = 6.1, n = 12)

Width: 9 to 17 mm ($\overline{X}$ = 12.3, s = 1.9, n = 39)

Thickness: 2 to 6 mm ($\overline{X}$ = 3.6, s = .8, n = 48)

Haft length: 4 to 9 mm ($\overline{X}$ = 6.9, s = 1.2, n = 45)

Basal width: 6 to 13 mm ($\overline{X}$ = 8.7, s = 1.7, n = 34)

Temporal and spatial distribution and references:

Suhm, Krieger, and Jelks (1954: 84) allow Scallorn points a time range from about A.D. 700 to 1500. Sequoyah points, subsumed here under the Scallorn class, are dated from about A.D. 1000 to 1350 at the Spiro site. Scallorn points are widely distributed, occurring throughout Texas, Oklahoma, Missouri, in most sections of the Mississippi Valley region, and onto the Central Plains.

In southwest Missouri they are the most frequently occurring of all arrowpoints. Thirty-eight were recovered from open sites during Stage I and II surveys in Truman Reservoir (Roper and Piontkowski 1979), several hundred were found in the burial tumuli, and many have been recovered from shelters. Excavations show that Scallorn points are the first type of arrow used in the area, probably in the Late Woodland period. They occur in a stratigraphic unit at 23HI297 which has been dated at A.D. 600±150 (Appendix B, Vol. I). Their co-occurrence with Fresno and Reed points in later assemglages indicate that Scallorn points were in use for a fairly long period. Evidence from the burial tumuli indicates that this period may have extended into the period of Euro-American contact (Goldberg, Vol. III). A single date on a Scallorn point from BE6 (Mound 2) places it firmly in the Mississippian period – A.D. 1250±50 (Appendix B, Vol. I).

Category 323 – REED – n = 14 (Plate 11o-r)

Basic description:

Blade: triangular with straight sides; thin to medium biconvex cross-section

Shoulders: straight with concave edges

Notches: shallow, moderately wide notches inserted at nearly a 90° angle to the medial axis; notches placed approximately 1/4 to 1/3 the distance between the base and the tip

Base: irregular and almost straight with rounded corners and lateral haft margins which usually contract slightly toward the notches

Size:

Length: 16 to 21 mm ($\overline{X}$ = 18.0, s = 2.0, n = 5)

Width: 9 to 15 mm ($\overline{X}$ = 11.1, s = 2.1, n = 12)

Thickness: 2 to 4 mm ($\overline{X}$ = 2.8, s = .6, n = 14)

Haft length: 4 to 11 mm ($\overline{X}$ = 6.4, s = 2.2, n = 14)

Basal width: 8 to 14 mm ($\overline{X}$ = 11.2, s = 2.2, n = 9)

Temporal and spatial distribution and reference:

The Reed type has been described by Baerreis (1954: 44) and Bell (1958: 76). Neither was able to fully describe the spatial range of the distribution. Many are found in Oklahoma where the point type was first named. Marshall (1958: 132) describes a type (Jakie Notched) from the Table Rock Reservoir Area which is similar. Two Reed points were recovered during previous shelter excavations in the area and several were found during the Stage I and II Truman Reservoir surveys on open sites.

Reed points in Oklahoma have been found in Caddoan assemblages. An estimated range has been given by Bell (1958: 76) as A.D. 500 to A.D. 1500.

Only one site, 23HI297, contained Reed points in an undisturbed context. Evidence from two different loci at 23HI297 shows that Reed points generally co-occur with Scallorn points in Late Woodland assemblages, and similarly extend into the latest prehistoric period with Fresno points. They occur there in an assemblage which has dates of A.D. 950±100 and A.D. 911±103 (Appendix B, Vol. I).

Category 334 – FRESNO – n = 12 (Plate 11s-u)

Basic description:

Blade: triangular with edges either straight or slightly convex; moderately thin biconvex or plano-convex cross-section; blade not always totally retouched on both surfaces

Shoulders, notches, stem: none

Base: either straight or subconvex with rounded corners or subconcave with sharply angular corners

Size:

Length: 17 to 33 mm ($\overline{X}$ = 23.7, s = 5.8, n = 6)

Width: 8 to 16 mm ($\overline{X}$ = 12.8, s = 2.6, n = 12)

Thickness: 2 to 4 mm ($\overline{X}$ = 3.1, s = .7, n = 12)

Haft length: 0

Basal width: 8 to 16 mm ($\overline{X}$ = 6.0, s = 7.2, n = 11)

Temporal and spatial distribution and references:

Many archeological point classifications include subdivisions of the points classified here as Fresno points. For example Purrington (1971) distinguished between points with three straight sides (Fresno), two straight sides with a concave base (Maud), and two excurvate sides with a straight base (API). It seems that these sub-types may just represent regional variants of the simple triangular form. Since this regional variation has not been well delimited or quantified, all three subtypes are combined here.

Because of the simple form of the Fresno point and its widespread distribution, it is impossible to attempt to use this point form as an indicator of cultural affiliation. Simple triangular points are found throughout North America and in some places were "undoubtedly independently derived" (Purrington 1971: 73). While the Fresno point is a widespread type, its age affiliation is more clearcut. In most regions it is found in late prehistoric contexts. It is commonly associated with Mississippian pattern cultures (Bell 1960:44). Suhm and Kreiger (1954: 498) assign its temporal range from A.D. 800 or 900 to A.D. 1600 or later. Of all arrowpoints recovered in the Stage I and II Truman surveys, Fresno is the most ubiquitous type, with the exception of Scallorn points; 14 were collected (Roper and Piontkowski 1979). Stratigraphic evidence from excavations at three sites in the reservoir shows that while Fresno points occur in Late Woodland assemblages, they are most prevalent in the latest prehistoric occupations of the region. Two thermoluminescence dates have been obtained for components which include Fresno points. A pit feature at 23HI297 is dated at A.D. 1717±64. From 23CE123, a burial cairn, a Fresno point itself was dated A.D. 1150±60 (Appendix B, Vol. I).

Category 351 – HUFFAKER – n = 1 (Plate 11V)

Basic description:

Blade: isosceles triangle with straight lateral margins

Shoulders: at a right angle to the long axis of the point

Notches: small elliptical side-notches

Haft: wider than the widest portion of the blade, with a squared-off appearance between the proximal point of juncture of the notch with the lateral margin and the basal corner.

Base: slightly concave, with a basal notch that is the same size as the side notches

Size:

Length: incomplete

Width: 13 mm

Thickness: 4 mm

Haft length: 9 mm

Basal width: 13 mm

Temporal and spatial distribution and references:

The Huffaker point, named by Baerreis (1954: 44) from specimens in northeast Oklahoma, is found throughout most of the Plains and eastward to Illinois (Bell 1960: 58).

Only one specimen was recovered from an open site in the Truman Reservoir area, and this is a surface find. However, several specimens recovered from burial tumuli indicate that this type occurs in the latest prehistoric period in the area in association with Harrell, Washita, and Fresno types (Goldberg, Vol. III). Based on their occurrence at Spiro Focus sites, Bell (1960: 58) offers an approximate temporal span for the type from A.D. 1000 to 1500.

Category 352 – unclassified arrow A – n = 1 (Plate 11w)

Basic description:

Blade: long and narrow with excurvate lateral margins and a thick cross-section

Shoulders: indistinct

Notches: shallow but broad indentations; the blade lateral margins, shoulders, and notches form a long continuously recurvate edge

Haft: long and distinguished from the blade by heavy lateral grinding

Base: slightly convex, heavily ground

Size:

Length: incomplete

Width: 10 mm

Thickness: 6 mm

Haft length: 12 mm

Basal width: 10 mm

Comments and temporal position:

Unknown. Is a surface specimen in this collection.

Category 353 — unclassified arrow B — n = 1 (Plate 11x)

Basic description:

Blade: broadly triangular with straight lateral margins

Shoulders: wide and with thin barbs that extend about 1/3 the length of the haft

Notches: large and deep, almost circular

Haft: proportionally long with a narrow neck and incurvate expanding lateral margins

Base: slightly convex and ground

Size:

Length: original length was not much longer than the remaining 18 mm

Width: 16 mm

Thickness: 3 mm

Haft length: 7 mm

Basal width: incomplete

Comments and temporal position:

Unknown. The present specimen occurs in surface context with a variety of other dart and larger projectile points.

Category 333 — unclassified arrows — n = 25

All but two of the specimens in this class consist of the blade portions of tools which by virtue of their size and general shape are arrow points. However, because the bases have been broken, more specific categorization is impossible. All are triangular, with straight lateral margins. Only one is serrated.

The other two specimens are similarly unclassifiable as anything but arrows. One is the haft element of a point which may have been either side- or corner-notched. The other specimen is corner-notched, with a slightly expanding stem, barbs, and a straight base. Its form is amorphous as the result of reworking and several breaks. It is therefore unclassifiable.

These broken specimens co-occur with other arrow forms (i.e., Scallorn, Reed) in excavated context and presumably date to a Late Woodland period.

Size:

Length: two complete lengths are 21 and 23 mm

Width: 8 to 22 mm ($\overline{X}$ = 13.6, s = 3.7, n = 13)

Thickness: 2 to 6 mm ($\overline{X}$ = 3.4, s = .9, n = 25)

Haft length: 7 to 10 mm ($\overline{X}$ = 8.0, s = 1.4, n = 4)

Basal width: the measureable specimen is 11 mm

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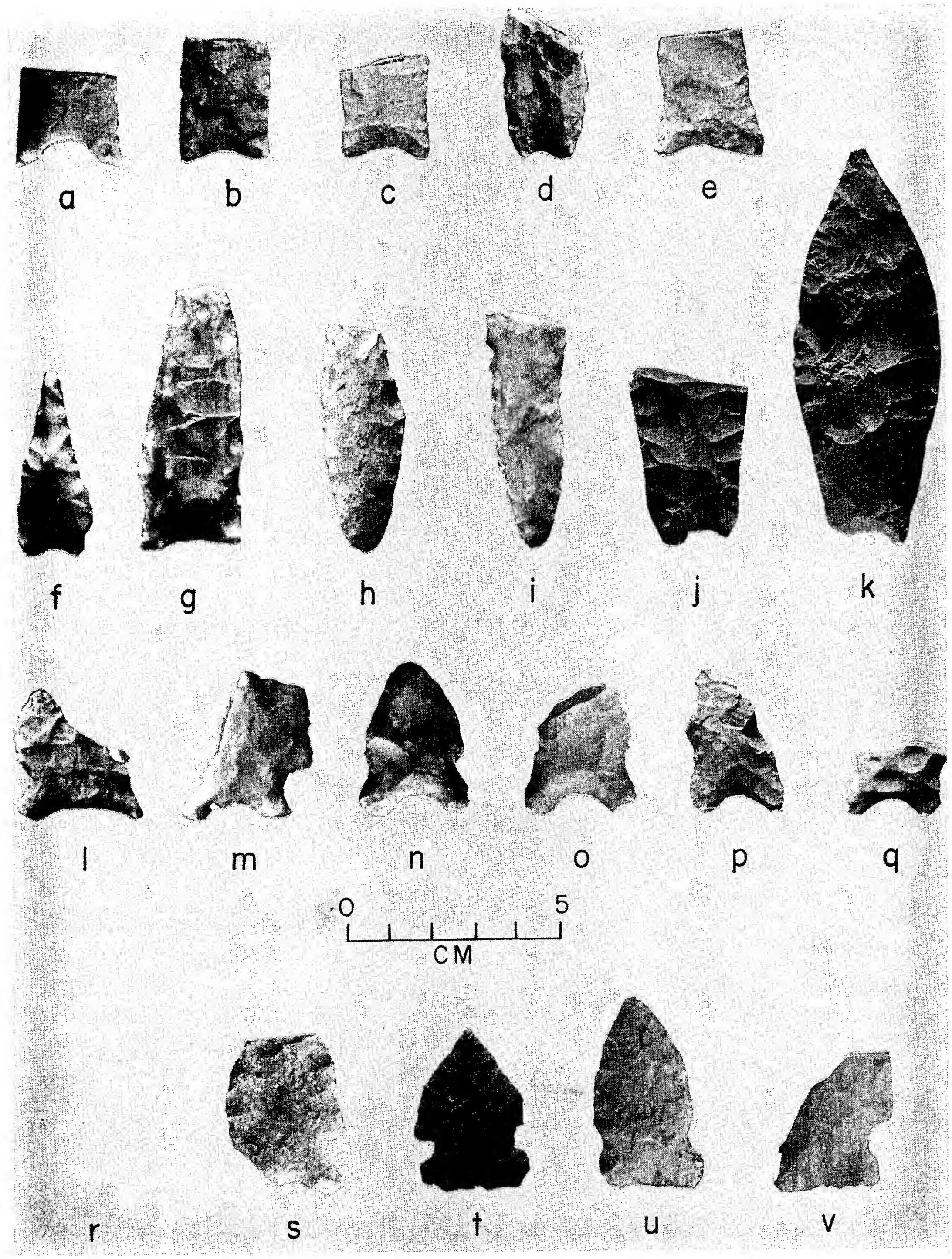

Plate 1. Lanceolate and side-notched points. a, unfluted Paleo-Indian lanceolate (Cat. 385); b, d, Plainview (Cat. 349); c, e-g, Dalton (Cat. 350); h-i, Nebo Hill (Cat. 344); j-k, Sedalia (Cat. 335); l-m, Hardaway Side-Notched (Cat. 384); n-q, Dalton variant (Cat. 376); r-s, large bifurcated base (Cat. 374); t-v, Graham Cave (Cat. 375).

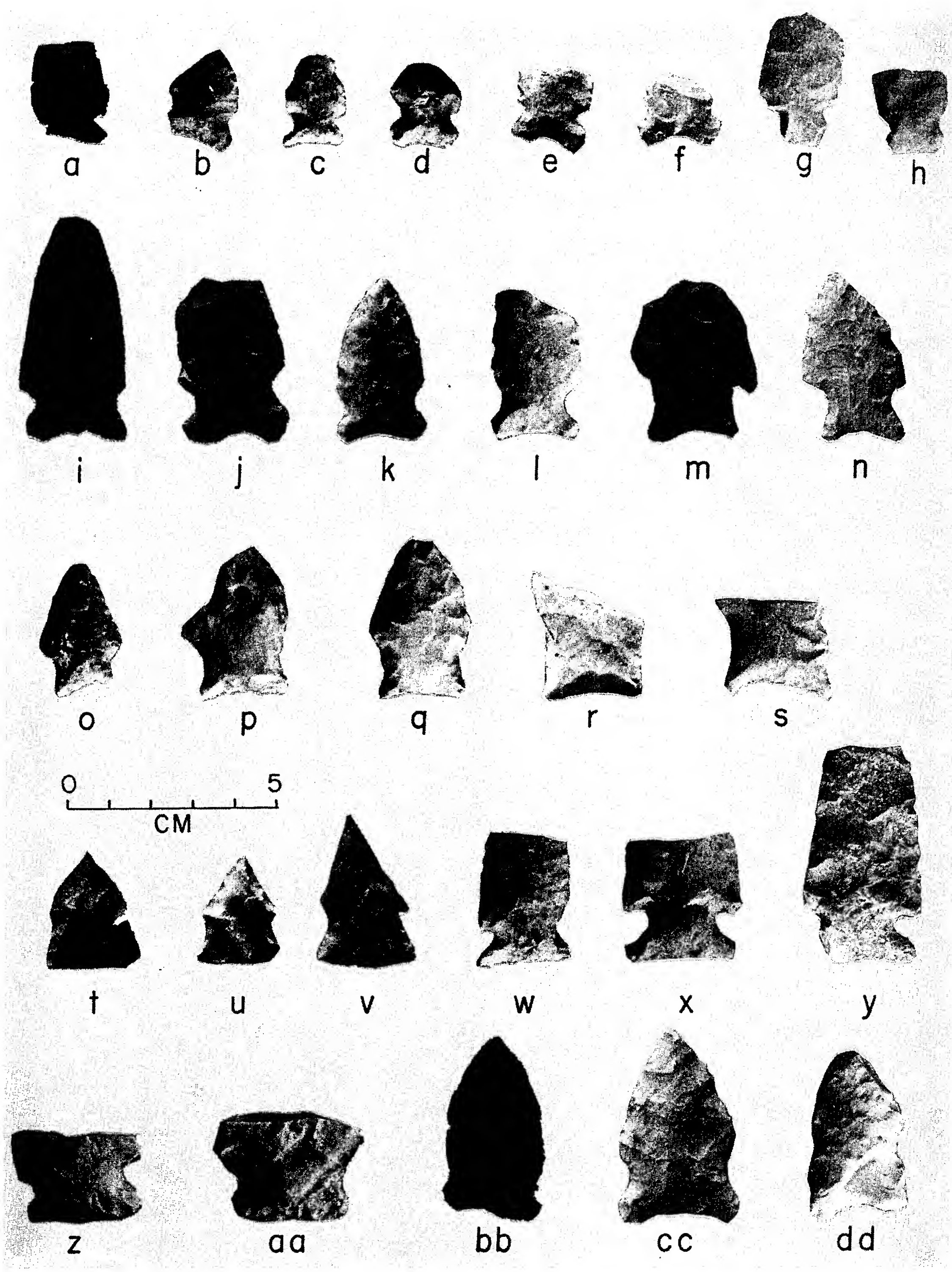

Plate 2. Side-notched points. a-d, small triangular-bladed, side-notched darts (Cat. 368); e-f, concave based, side-notched dart (Cat. 369); g-h, straight-based side-notched (Cat. 370); i-l, Big Sandy (Cat. 378); m-o, Jakie Stemmed (Cat. 371); p-s, flared base B (Cat. 372); t-v, small, shallow side-notched (Cat. 320); w-y, small, narrow, side-notched (Cat. 321); z-aa, small notched, rounded corners (Cat. 361); bb-dd, weakly side-notched (Cat. 377).

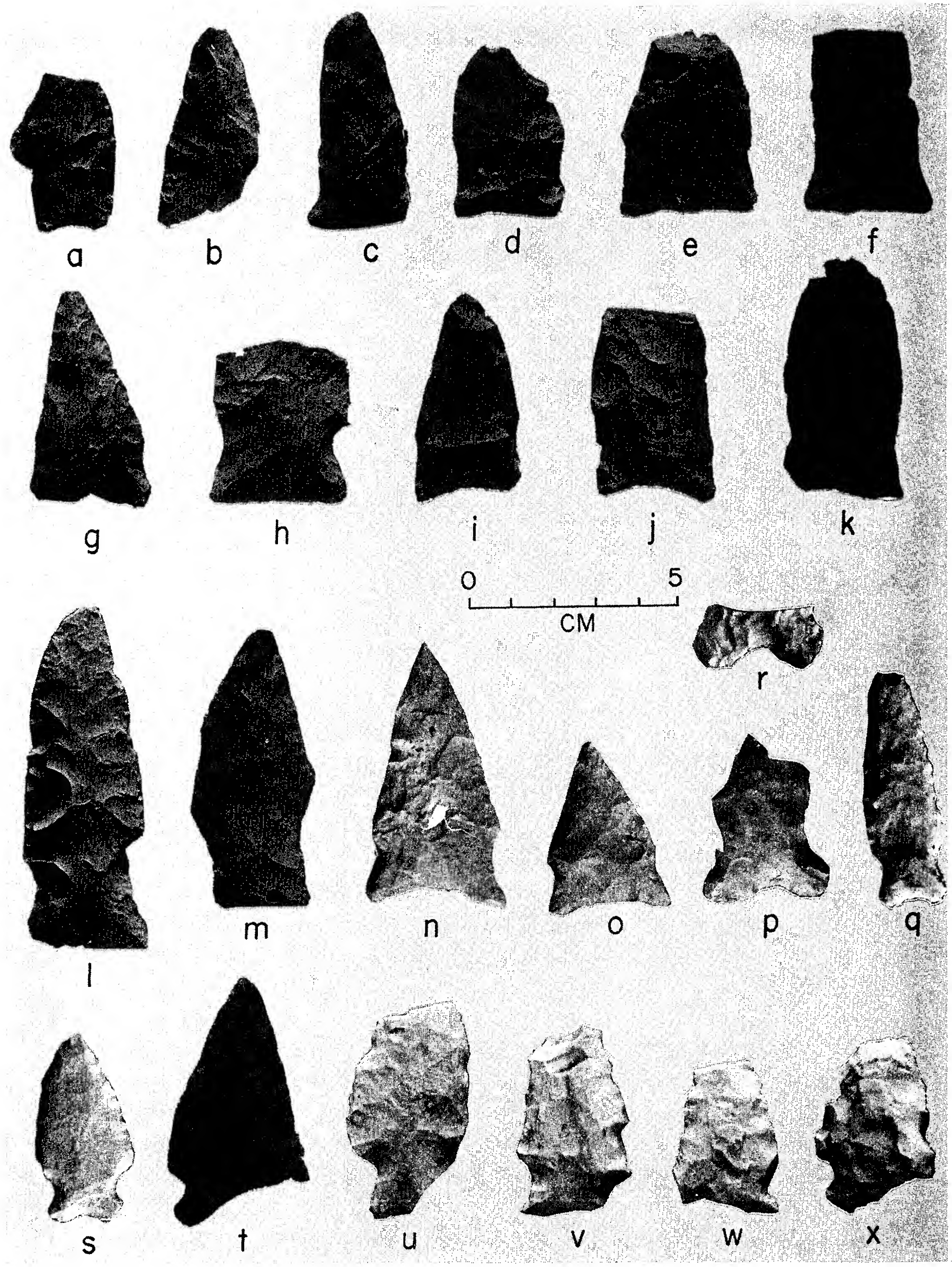

Plate 3. Side-notched points. a-m, Rice Side-Notched (Cat. 325); n-o, shallow notched (Cat. 324); p, r, large, lobed base (Cat. 379); q, s, small, lobed base (Cat. 380); t, wide, side-notched (Cat. 381); u-x, poorly made side-notched (Cat. 382).

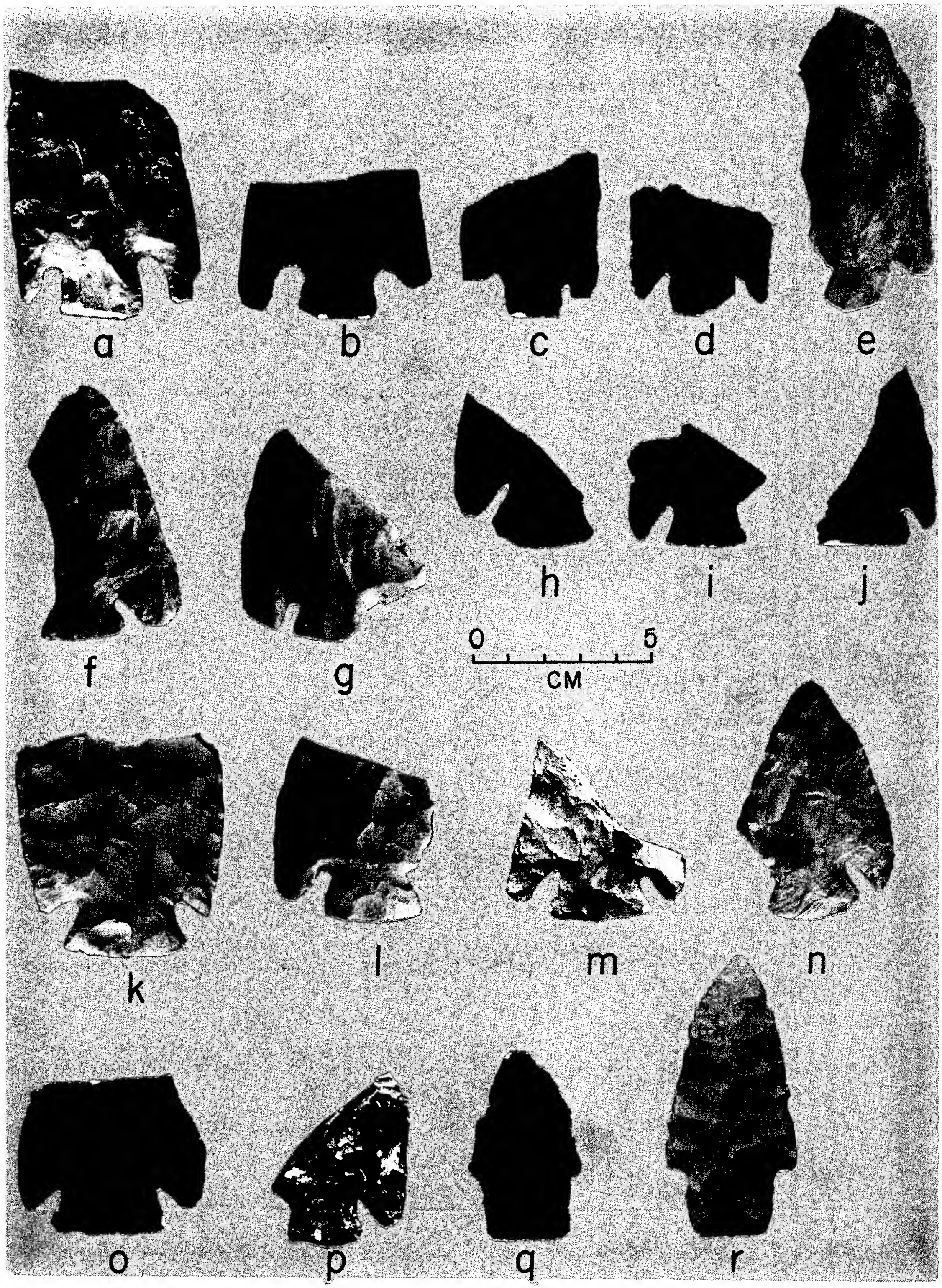

Plate 4. Basal-notched and straight stem points. a-d, Smith (Cat. 326); e, basal-notched (Cat. 329); f-g, l, n, Truman Broad-Blade Variant A (Cat. 327); h-k, m, o-p, Truman Broad-Blade Variant B (Cat. 328); q-r, Stone Square Stem (Cat. 337).

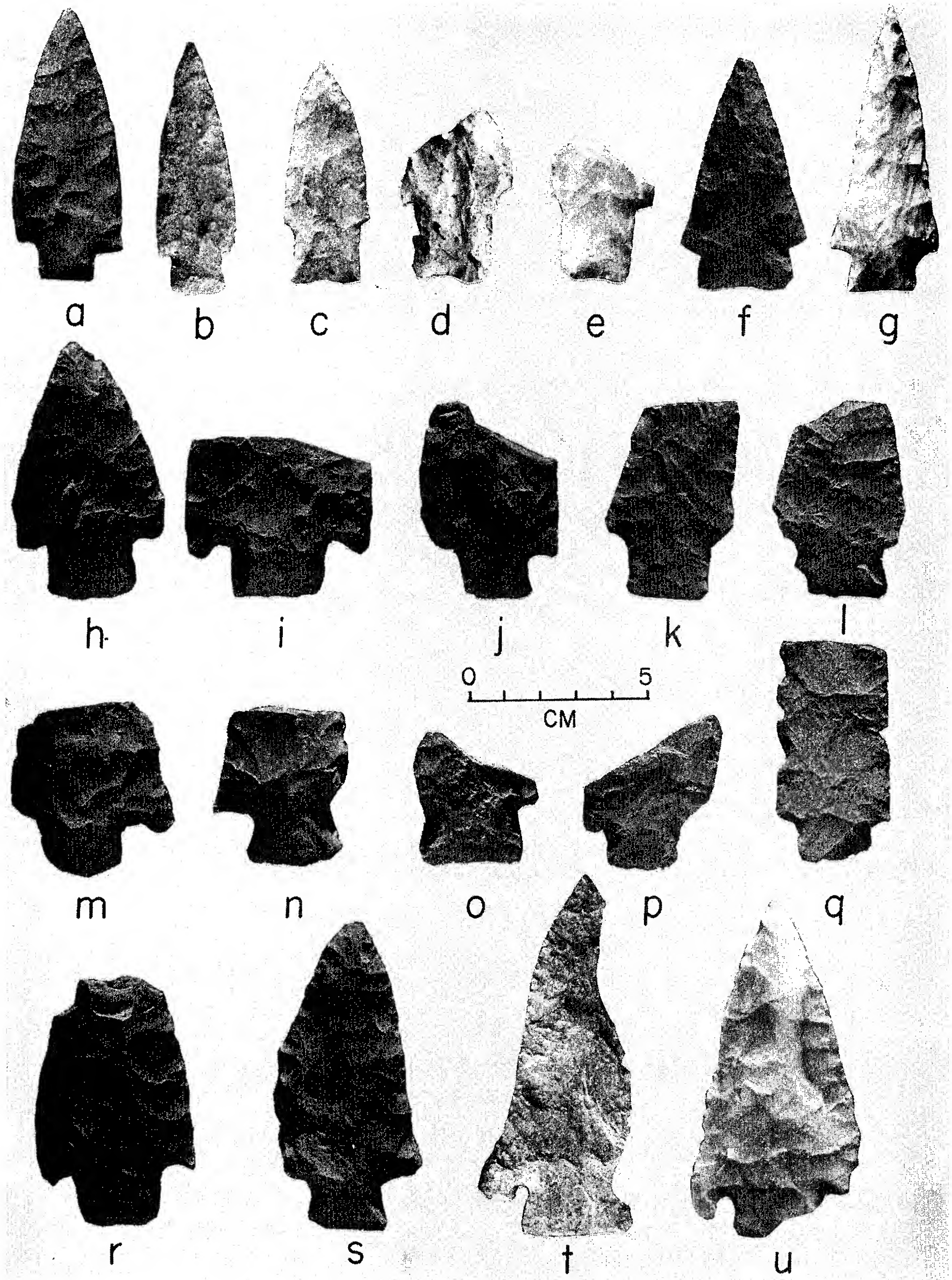

Plate 5. Straight stem points. a-c, medium sized, short, straight stemmed darts (Cat. 336); d-e, Stone Square Stem (Cat. 337); f-g, straight stemmed, angular shouldered and barbed darts (Cat. 338); h-s, Etley Variant A (Cat. 339); t-u, Etley Variant B (Cat. 341).

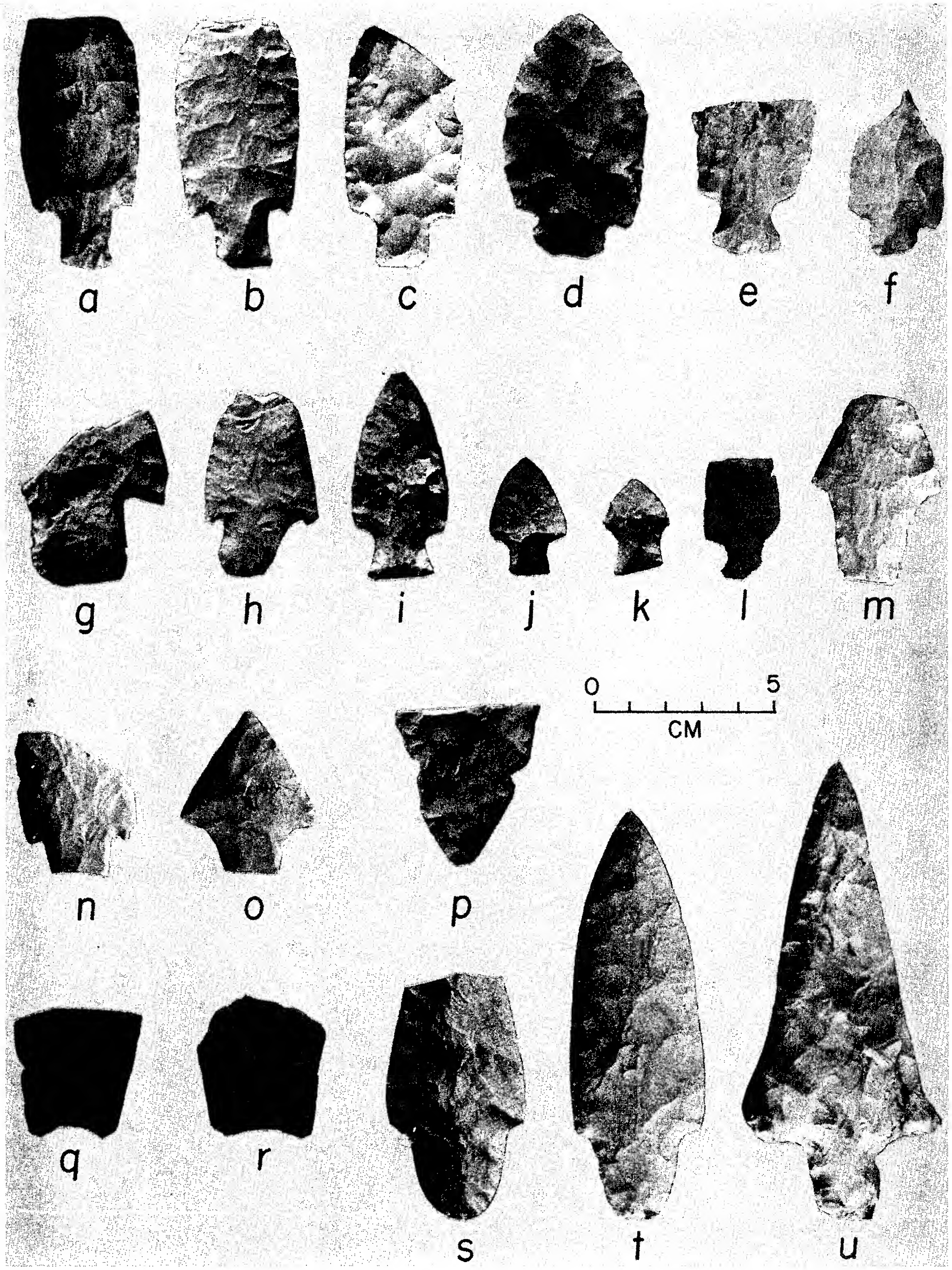

Plate 6. Straight stem and contracting stem points. a-f, small haft, straight stemmed (Cat. 355); g-h, miscellaneous straight stemmed (Cat. 362-1&2); i-l, Table Rock Stemmed (Cat. 342); m-o, general contracting stem (Cat. 331); p, Turkey Tail (Cat. 365); q-r, unclassified contracting stemmed A (Cat. 345); s-t, Waubesa (Cat. 348); u, unclassified contracting stemmed C (Cat. 347).

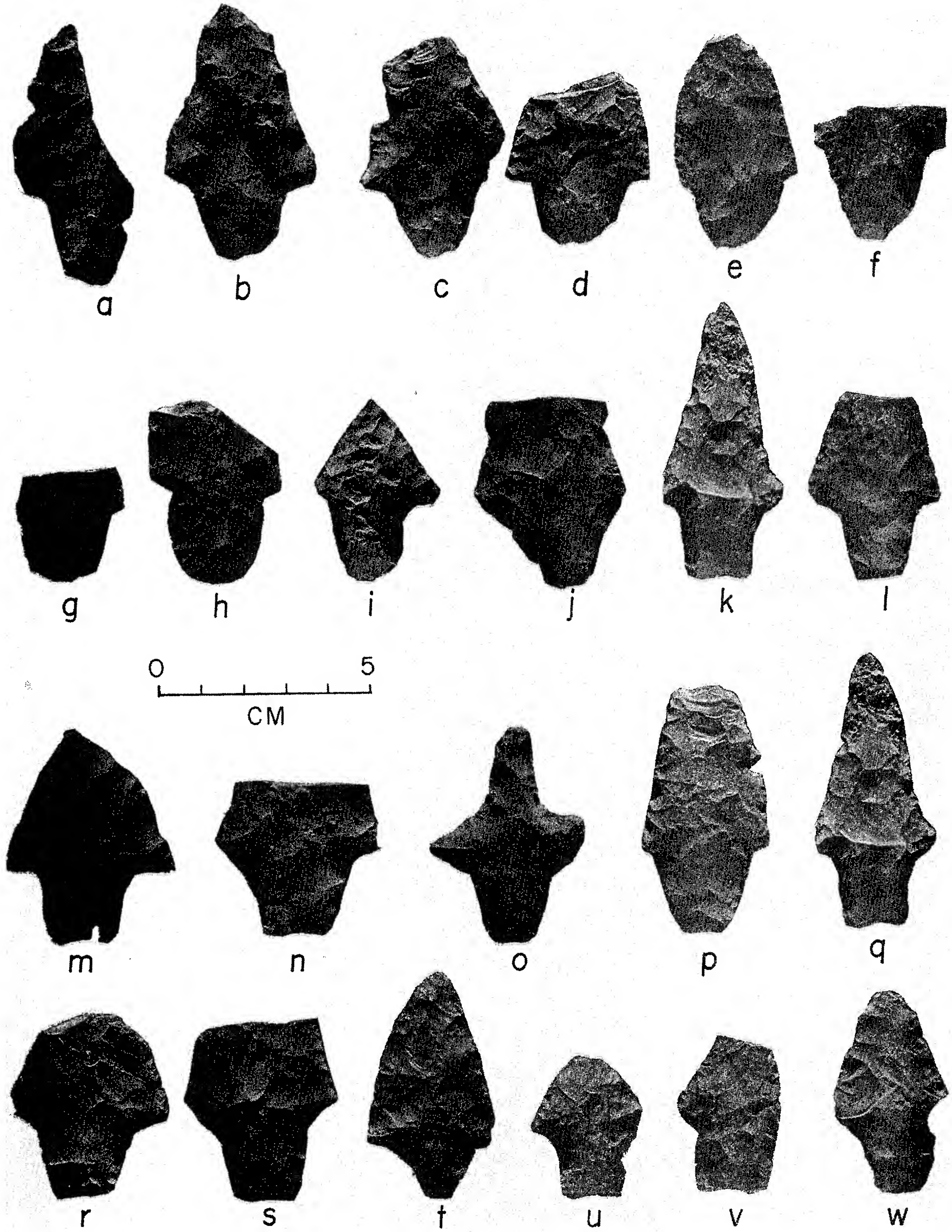

Plate 7. Contracting stem points. a-j, Gary (Cat. 330); k-w, Standlee (Cat. 332).

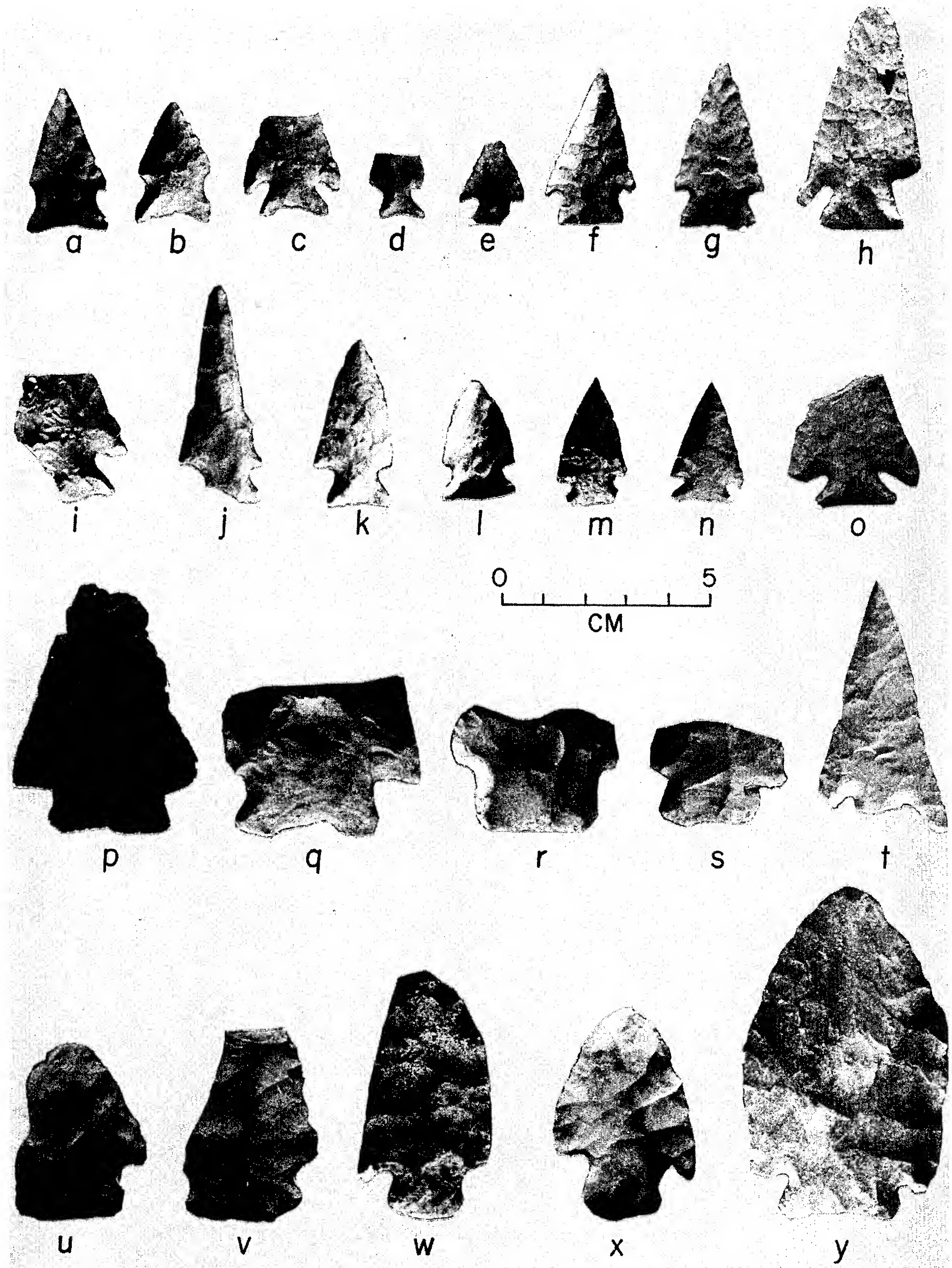

Plate 8. Corner-notched points. a-b, small notched, concave-based (Cat. 301); c-e, small, corner-notched, concave-based (Cat. 302); f-g, small, corner-notched, straight-based (Cat. 306); h-i, small, narrow-corner-notched, barbed (Cat. 315); j-l, small corner-notched (Cat. 303); m-n, short, sharply expanding based (Cat. 304); o, narrow, deep notches (Cat. 356); p-s, Rice-Lobed (Cat. 354); t, narrow notch, no haft (Cat. 358); u-v, crude, square notched (Cat. 360); w-x, bulbous haft, barbed (Cat. 363); y, large angular blade (Cat. 367).

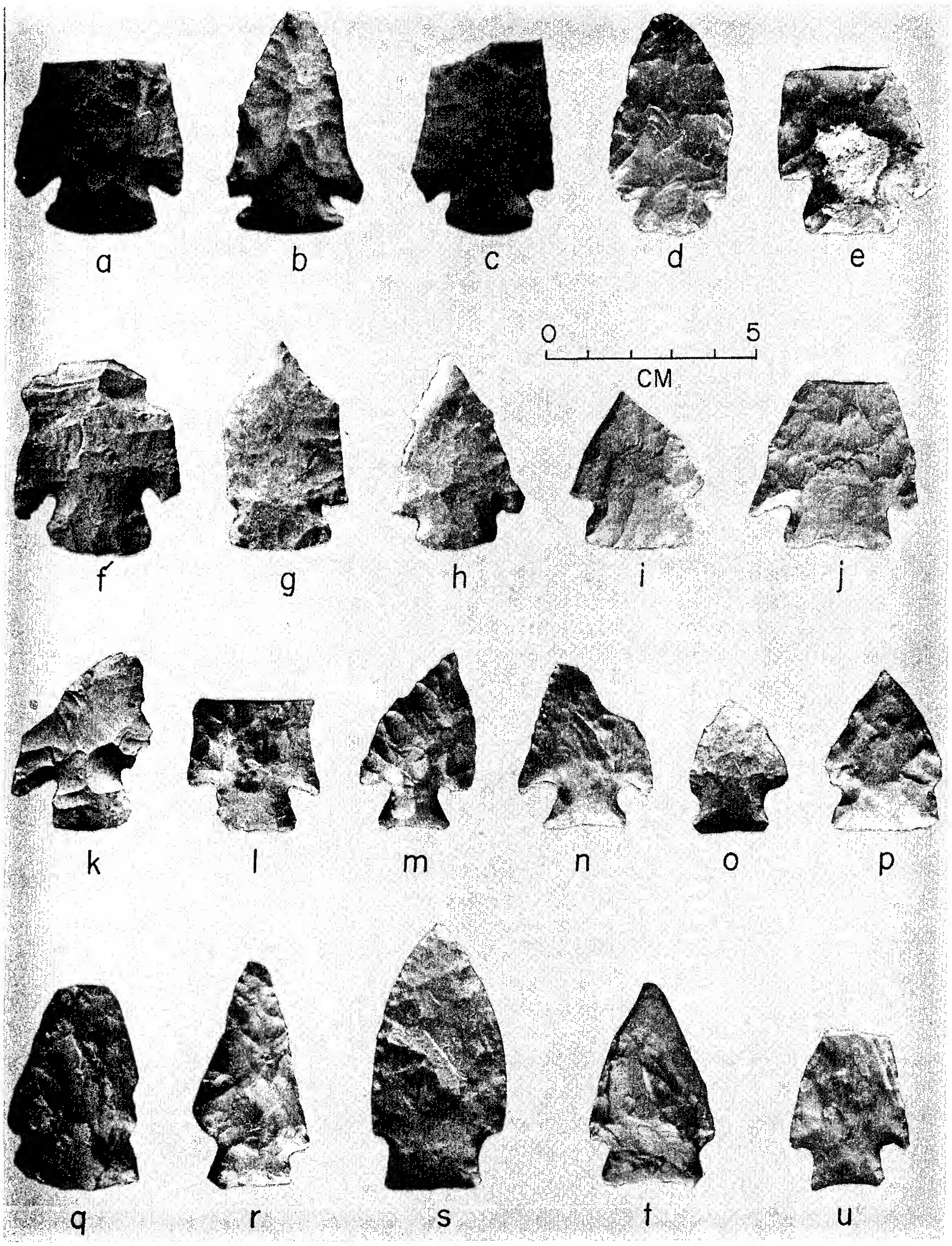

Plate 9. Corner-notched points. a-j, Afton (Cat. 307, 313, 316); k-l, Afton-like (Cat. 312); m-o, medium, elliptical corner-notched (Cat. 309); p-r, expanding stem (Cat. 314); s-u, eared stemmed points (Cat. 359).

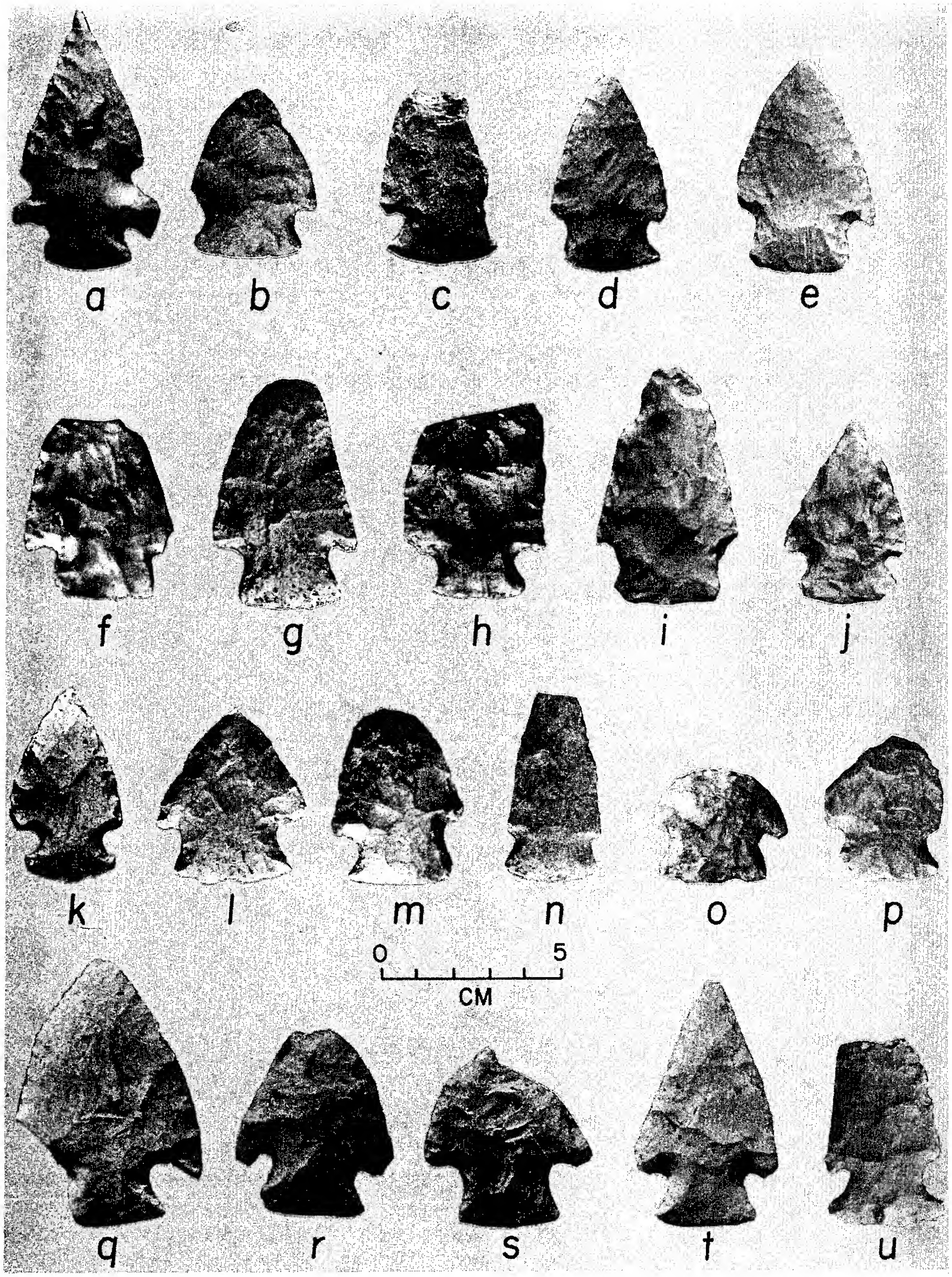

Plate 10. Corner-notched points. a-h, corner-notched with angular to barbed shoulders (Cat. 310); i-p, shallow corner-to-side-notched (Cat. 311); q-t, Snyders (Cat. 317); u, Cupp (Cat. 357).

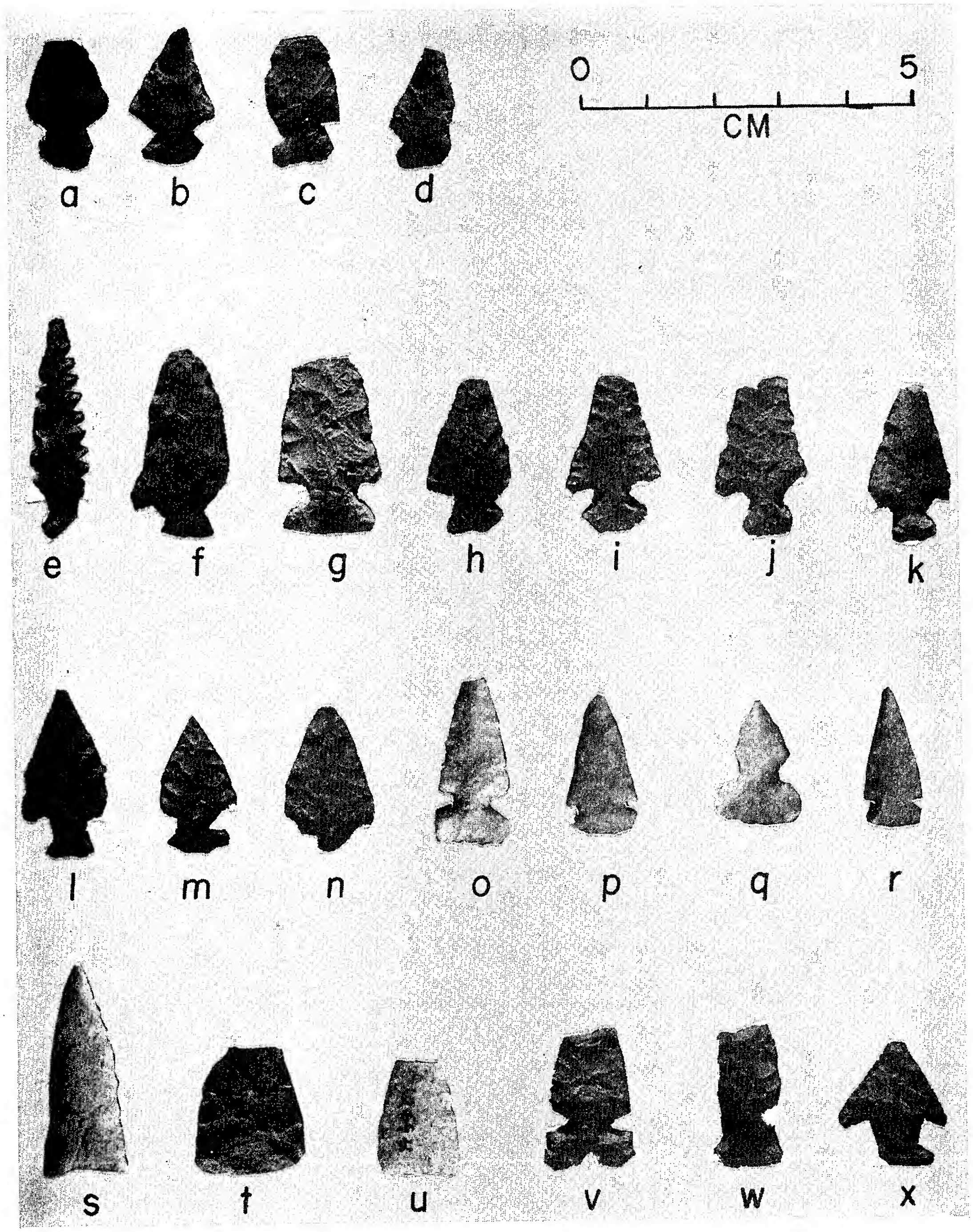

Plate 11. Arrows. a-n, Scallorn (Cat. 322); o-r, Reed (Cat. 323); s-u, Fresno (Cat. 334); v, Huffaker (Cat. 351); w, unclassified arrow A (Cat. 352); x, unclassified arrow B (Cat. 353).

PART II.

CERAMICS

by

V. Ann Tippitt

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Introduction

Ceramic materials constitute a very small part of the total volume of the archeological material recovered during the Stage 3 survey and the excavations in the Truman Reservoir. This report describes the ceramic materials from the Stage 3 survey and four excavated open sites. These materials will then be placed in perspective through a brief overview of ceramic variability in the Pomme de Terre and Osage River basins.

Preliminary inspection revealed that most of the sherds recovered were very small and in poor condition. The exterior and interior surfaces were badly eroded and surface treatment observations on many specimens were not possible. Sherds that were smaller than 1 cm^2 were classified as indeterminate small and were not analyzed. Only counts per excavation unit by level were recorded. When it was not possible to determine the surface treatment, these sherds were classified as indeterminate and only temper material, temper size, and frequency were recorded.

Survey Ceramics

A total of forty-eight sherds were recovered during the survey. Thirty-two of these sherds were collected from one site, viz., 23BE681. Provenience of the remaining surface collected sherds is shown in Table 1.

Excavated Ceramics

23HI297 - CROSS TIMBERS SITE

Site 23HI297 is a large multicomponent site located on the T-1b of the Pomme de Terre River just north of Blackwell Cave. The deposit is at least two meters deep in parts of the site; however, ceramics occur only in the upper 50 cm. The majority of sherds is small. The edges and surfaces are badly eroded and leached due to exposure and cultivation. The material was very homogenous. All sherds contain fine

TABLE 1

Survey Ceramics

Site Number	No. of Sherds	Temper	Surface Treatment
23BE136	1	limestone	smoothed
23BE240	1	grit	smoothed
23BE287	1	limestone	smoothed
23BE331	1	limestone	smoothed
23BE375	1	limestone	smoothed
23BE387	1	limestone	smoothed
23BE389	1	limestone	indeterminate
23BE432	1	limestone	smoothed
23BE512	1	limestone	smoothed
23BE537	1	limestone	indeterminate
23BE626	1	limestone	smoothed
23BE699	1	limestone	smoothed
23BE829	1	limestone	smoothed
23SR514	1	limestone	smoothed
23HE13	1	limestone	smoothed
23HE346	1	grog	smoothed

crushed limestone temper, although occasional large pieces of temper are present. Thickness varies from 8 to 11 mm. Although the surfaces are worn, it appears that the surface was smoothed on most of the sherds. Two small, thick sherds with clear cord impressions were recovered. Color of the sherds varies from buff, red-orange, to dark red-brown. No rims or bases were recovered. The ceramics from this site are similar to an aggregate of pottery and seemingly related materials described by Chapman (1948: 100-110) as Highland Aspect. However, he acknowledges that this term has now been discarded, and some of the included materials originally attributed to the Late Woodland period have been found to be related to both earlier and later periods (Chapman 1980: 100).

THE RED TAIL SITE - 23BE681

This small site is located on the edge of a T-1b along an old channel of Little Tebo Creek. A large dense lithic scatter covered the surface of this site. Thirty-two ceramic sherds, including two rims, were collected from the surface.

Hopes for an open site with good ceramic preservation below the plowzone were not realized. The deposit was only about 60 cm deep and ceramics were scarce below the plowzone. In all, few sherds larger than a Susan B. Anthony dollar were recovered. Ninety percent of the sherds were limestone tempered and were similar to those described for Site 23HI297. There were a few buff colored sherds with sand temper.

A total of 32 sherds was collected from the surface during transect survey, and 43 sherds were recovered from the excavation. All of the sherds are small and highly weathered. The majority have a smooth or plain surface; the predominant tempering material is limestone. Temper size varies from 0.5 mm to 1.0 mm in diameter. Temper density is 20-30%. The paste, temper, and thickness of these sherds are similar to those attributes described for pottery characteristic of the Late Woodland period (Chapman 1980: 100). The small rim from the surface collection has a slightly everted profile.

THE TERRE BABY SITE - 23BE337

The Terre Baby site is a large multi-component site on a T-1b of the Pomme de Terre River. Ceramic material was confined to the surface and plowzone (Table 2). Although numerous, the sherds were all very small and eroded. The limestone temper had been leached from the surfaces and edges of many of the sherds. The exterior surface of many of the sherds was in poor condition, but it was possible to determine smoothed and cord impressed surface treatment. No rims or bases were recovered.

TABLE 2

Ceramics from 23BE337

Provenience	Temper Limestone	Surface Treatment	Indeterminate Small
Surface	12	smoothed	
	4	cord marked	
Plowzone	1	cord marked	5

THE COOTIE SITE - 23BE676

This is a multicomponent site located on a cutoff meander loop of the South Grand River west of its confluence with the Osage River. Like other sites in the reservoir area, there are a large number of small sherds, most of which are body sherds with limestone temper (Table 3).

The majority of these sherds is from the upper 30 cm of the deposits. Both plain and cord impressed surface treatments are represented, but there are no rims or bases. A second ceramic ware is represented at this site. There are six body sherds and one rim sherd of a grit tempered vessel. The grit is feldspar, plagioclase and angular quartz. The paste is compact and buff to light yellow-brown in color. The surface of the body sherds is badly eroded. The small rim sherd is beveled. Below the lip is a row of depressions, perpendicular to the rim. It is too worn to determine if this is the result of a cord wrapped stick or a smooth dowel.

Discussion

Although the information is very sparse, patterns can be seen in the distribution of limestone tempered pottery in the Osage River drainage. Ceramic assemblages similar to those just described have also been recorded from the following sites: Miller (23BE151; Vehik 1974), Merideath (23SR129; Falk 1969), Thurman (23HE151; Falk and Lippincott 1974), and Fulton (23BE152; Falk and Lippincott 1974). These sites are all located along terraces of the Pomme de Terre, the lower reaches of Tebo Creek, or Little Tebo Creek. At least five sites with limestone tempered pottery are distributed along Little Tebo Creek within 10 miles of one another. One of these sites, 23BE681, was tested during the 1978 field season.

Limestone tempered pottery also occurs in rock shelters along the Osage, but it is more prevalent in the shelters along the Pomme de Terre, for example, at Blackwell Cave (23HI172; Wood 1961; Falk 1969) and Rodgers Shelter (23BE125). Many of these shelters are located along the bluff edge but still fairly close to open sites along the terraces that also contain limestone tempered pottery. A good example of this situation is Saba Shelter and the Miller site.

Pottery has also been recovered from two of the springs along the Pomme de Terre: Boney Spring and Phillips Spring. Several limestone tempered, cord marked sherds were recovered from Phillips Spring (Chomko 1976). One sherd with a zone dentate design was also recovered. Boney Spring contained a Woodland vessel exhibiting vertical cord marking and fine limestone temper (Wood 1976). The deposits also included several fine sand tempered sherds.

TABLE 3

Ceramics from 23BE676

Excavation Unit	Frequency	Temper	Surface Treatment Smooth	Cord Marked	Indeterminate	Unidentified
Test Pit 1	1	grit			X	
Test Pit 3	1	grit	X			
1S 13W - 40-50	1	limestone			X	
0S 15W - 10-20	1	grit			X	
1S 16W - 20-30	1	limestone			X	
1S 17W - 20-30	3	limestone		X		
0S 18W - 10-20	1	limestone		X		
0S 20W - 30-40	1	grit			X	
0N 7W - 0-10	2	grit			X	
0N 8W - 10-20	5	grit			X	
0N 13W - 10-20	4	limestone			X	
	2	grit			X	
0N 15W - 0-10	1	grit	X			
- 10-20	3	grit			X	
20-30	4	grit	X			
0N 16W - 10-20	1	grit			X	
0N 17W - 20-30	1	grit	X			
1N 9W - 14-20	3	grit			X	
1N 11W - 10-20	5	grit			X	
1N 12W - 0-10	2	limestone			X	
1N 14W - 10-20	4	grit			X	
1N 15W - 10-20	2	limestone			X	
1N 16W - 10-20	2	grit			X	
	2	limestone			X	
1N 17W - 10-20	1	limestone	X			
1N 23W - 10-20	1	limestone		X		
- 30-40	1	grit	X			
1N 24W - 10-20	2	grit			X	
2N 14W - 0-10	2	grit			X	
2N 15W - 0-10	1	grit			X	
2N 16W - 20-30	1	grit	X			
3N 14W - 0-10	1	grit			X	
3N 16W - 0-10	1	limestone			X	
3N 17W - 10-20	3	grit			X	
4N 17W - 0-10	1	grit			X	
5N 44W - 20-30	1	limestone			X	
- 30-40	7	grit	X			
- 50-60	1	grit	X			
4N 16W - 0-10	1	limestone				X
0N 14W - 10-20	1	limestone				X
1N 24W - 20-30	1	grit				X
1N 17W - 30-40	1	limestone				X
1N 23W - 50-60	1	grit				X
1S 15W - 20-30	1	grit				X
0N 17W - 10-15	1	grit				X
Test Pit - 50-60	1	grit				X
0N 8W - 20-30	1	grit				X
1N 23W - 30-40	1	grit				X
1N 7W - 10-20	1	grit				X
20W 0S - 30-40	1	grit				X
0N 15W - 10-20	6	grit				X
1N 12W - 10-20	1	grit				X
1N 17W - 0-10	1	grit				X
2S 17W - 10-20	1	limestone				X
Test Pit # - 0-10	1	limestone				X
1N 21W - 40-50	1	grit				X
1N 13W - 10-20	1	grit				X
2N 15W - 10-20	2	grit				X
1N 9W - 10-20	3	grit				X
3N 15W - 10-20	7	grit				X
2N 13W - 10-20	1	grit				X
3N 17W - 0-10	2	grit				X
1N 12W - 20-30	1	limestone				X
0N 17W - 10-20	1	grit				X
3N 14W - 0-10	2	grit				X
1N 23W - 10-20	1	grit				X
1N 18W - 20-30	1	grit				X
1S 12W	2	grit				X
3N 14W - 0-10	1	grit				X
1S 17W - 10-20	1	grit				X

Chapman (1980) provides an excellent summary of the ceramic assemblages from a number of shelters along the central Osage. The discussion also includes ceramic complexes from the Pomme de Terre. Early Woodland pottery is scarce throughout the entire area. Chapman (1980: 10) reports Early Woodland pottery from Boney Spring. The Ralph Deurr collection from Henry County also contains two or three Early Woodland sherds from surface collection.

Middle Woodland pottery has been identified in the following sites: Rodgers (Stratum IV), Blackwell Cave (Stratum IV/Component C), Tater Hole Shelter, Griffin Shelter, and Soledad Shelter (McMillan 1968). Middle Woodland pottery has also been reported in shelters in the Table Rock Reservoir. A Renner crosshatched rim and body sherds was recovered from Rockhouse Cave in St. Clair County.

Late Woodland pottery in the Pomme de Terre River valley is characterized by predominantly limestone tempering, although sand and grit do occur. Late Woodland pottery is also associated with the Fristoe Burial Complex.

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PART III.

HEMATITE

by

Donna C. Roper and Margaret A. Van Ness

HEMATITE

by

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Introduction

Hematite was the most common non-chert, non-clay mineral used aboriginally in the Truman Reservoir and the only non-chert, non-clay mineral represented in the collections made during the course of this contract. Abundantly available locally, hematite was used as a source of pigment and for the manufacture of tools. It is found on open sites, in shelters, and in burial mounds and is present in both survey and excavation collections. The primary purpose of this paper is to inventory and describe the hematite in these collections. Additionally, however, it is our purpose to describe the aboriginal use of hematite, as inferred from examination of the collections, to describe temporal and spatial variability in the use of hematite, and to relate its archeological occurrence to known sources. We thus follow up and expand upon the work done by House (1977) on hematite collected during the Cultural Resources Survey.

Hematite as a Mineral

Hematite (Fe_2O_3) is an oxide of iron and is the most important ore of iron. It is described as "a heavy, red to purplish red, dull to glistening mineral which leaves a red mark or streak" (Keller 1961: 56). This characteristic red color gives rise to the mineral's name which is derived from the Greek word haimatites, meaning "blood-like" (Leet and Judson 1965: 81). It has a close associate, limonite, which is described as "a heavy, yellow to brown, or brownish black mineral which always leaves a yellow to brown mark or streak" (Keller 1961: 57).

Hematite occurs in a variety of forms which are briefly outlined from a mineralogical standpoint by House (1977: 124-127). Some difficulty and ambiguity was encountered in fitting these classes to the archeological collections. An archeological classification therefore distinguished four

types of hematite in the Truman Reservoir collections. The first of these, and by far the most common, is here referred to simply as ordinary hematite. It is dark red, often dark brownish red, and varies in hardness. Its streak is dark red to dark brownish red. Specular hematite varies from somewhat coarse to very fine-grained in texture, has a bluish or steel grey color, a metallic luster, and a hardness greater than 5 1/2 on Mohs' scale of hardness. Red ochre is described by House (1977: 127) as "an amorphous form of hematite which is admixed with clay and other impurities." It has a hardness normally less than 2 1/2 on Mohs' scale and is bright red. It is also what some have described as hydrated hematite. Finally, what is here called limonite is a yellow or brownish yellow mineral that is often soft, and leaves a yellow or brownish yellow streak.

Sources of Hematite

Branson (1944: 399-400) lists eight types of iron ore deposits in Missouri. These include: (1) specular hematite from the pre-Cambrian porphyry in the St. Francois Mountains of the eastern Ozarks, (2) red and specular hematite from sink-like depressions in the north-central Ozarks, (3) a variety of types at the contact of the Pennsylvanian and older rocks, (4) secondary hematite from throughout the Ozarks, and (5) two types of limonite deposits (Branson 1944: 399). Keller (1961: 56) gives a similar description. Hematite of one type or another is relatively common throughout the Ozarks, although more common in the eastern Ozarks (Fig. 1; Branson 1944: 369). Place names such as Iron County, Ironton, and Iron Mountain reflect the importance of iron mining in the eastern Ozarks (Rafferty 1980: 127-128, 133-136).

Hematite does, however, occur along the western Ozark border and some good descriptions of its availability are contained in the reports of mineral surveys conducted in Benton and Hickory counties by Shumard (1867) and Broadhead (1880). While Shumard's descriptions are general, Broadhead's describe specific outcrops by legal location, thereby permitting a map to be drawn (Fig. 2). In general, the hematite comes from the Jefferson City formation (Shumard 1867: 9 who refers to this formation as the Second Magnesium Limestone; its identity as what is now called Jefferson City is confirmed by Branson [1944: 50]). Inasmuch as the Jefferson City formation has considerable exposure in the eastern half of the reservoir area, there are undoubtedly considerably more exposures of hematite than are described by Shumard and Broadhead and hematite can also be expected to be found in streambed gravels derived from Jefferson City bedrock.

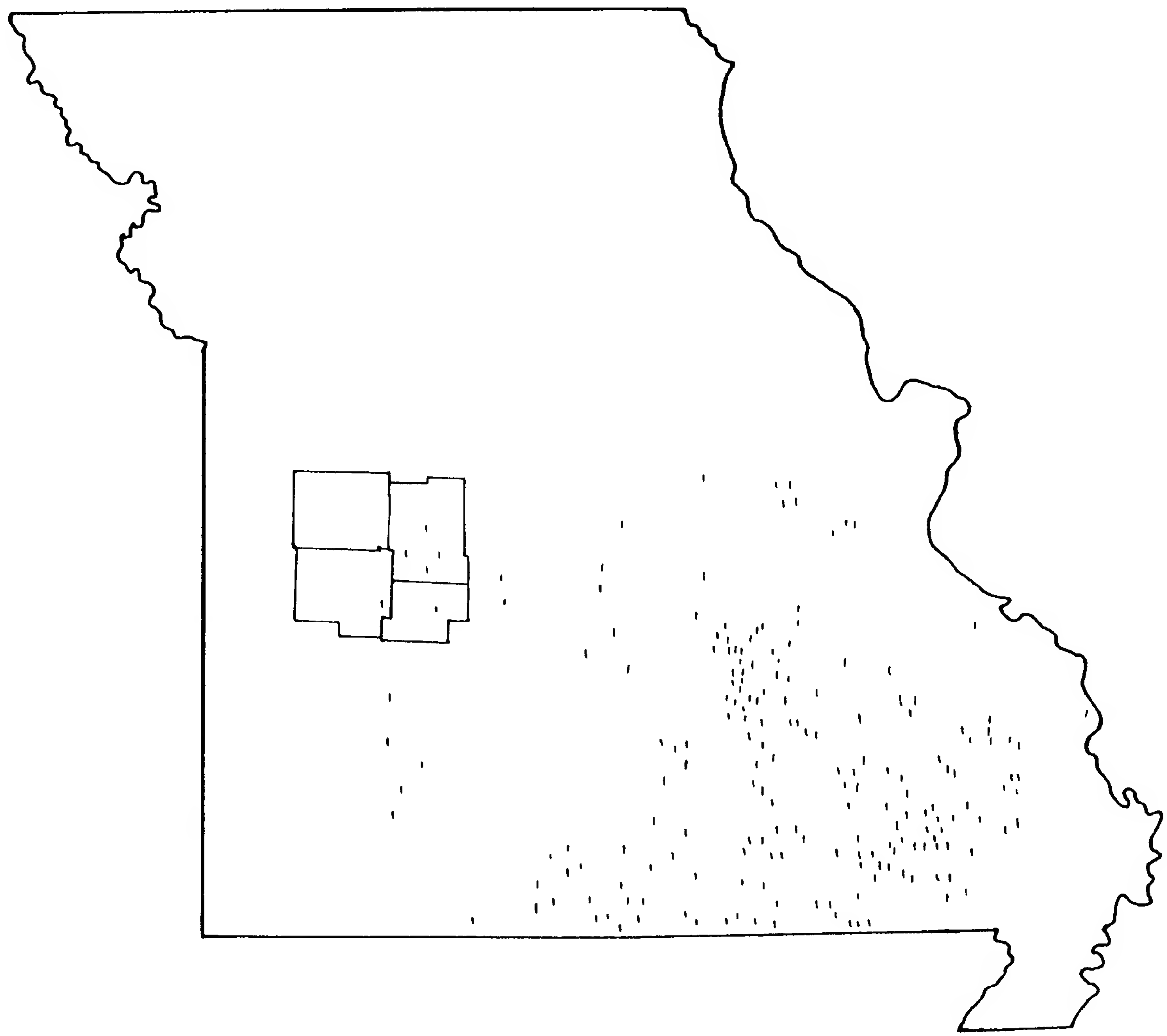

Figure 1. Hematite occurrences in southern Missouri (after Branson 1944: 369).

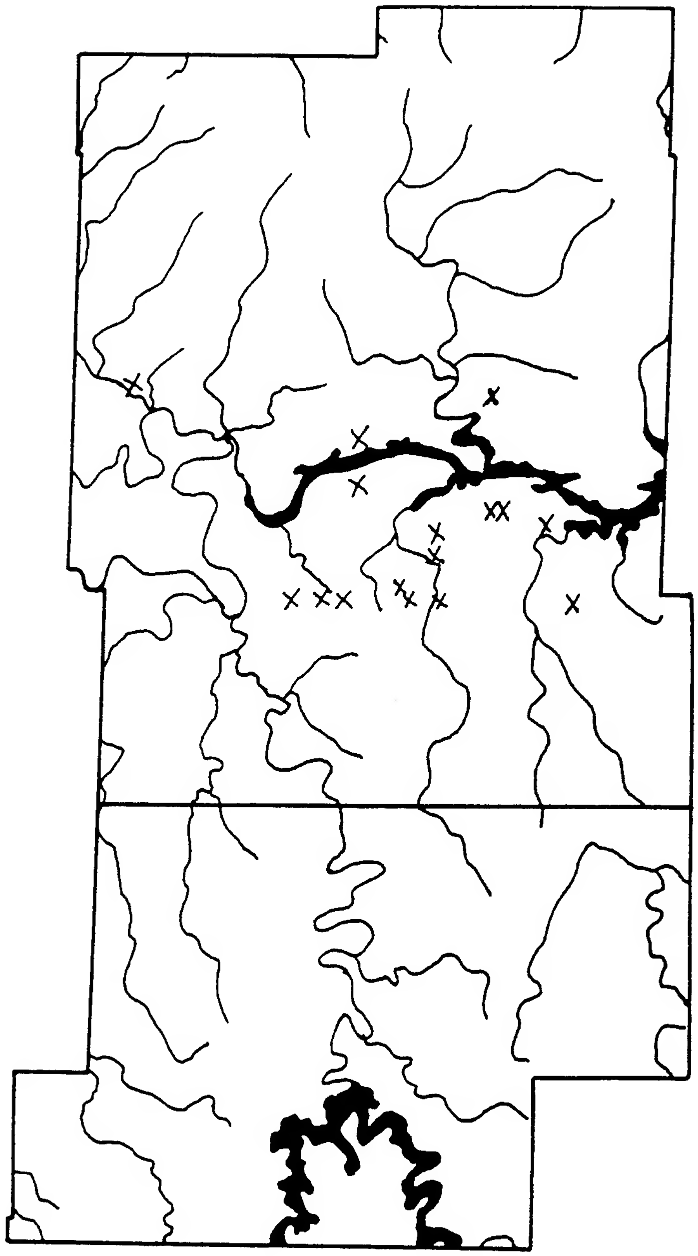

Figure 2. Hematite sources in Benton County (plotted from Broadhead 1880).

Analysis Procedures and Category Definitions

The hematite described here includes that from the Stage 3 survey, 1977-1979 excavations, Fristoe Burial Mounds, and the Stage 1 survey material that was not described by House (1977) although it had been separated and was quickly analyzable. The analysis procedures derive from three sources: (1) House's (1977) description of the Stage 2 survey hematite; (2) Kay's, et al. (1978) analysis of the Rodgers Shelter hematite; and (3) the basic format of the Lithics analysis and its interaction with the SELGEM computer file comprising the artifact catalog.

Recording was done in a format designed to be compatible with the SELGEM catalog. Its structure, therefore, is as shown in Figure 3. The state, county, general type (hematite), site number, and provenience categories are self-explanatory. Material type included the four hematite types described above (ordinary hematite, specular hematite, red ochre, limonite). Weight was measured to the nearest .1 gm. Length, width, and thickness measurements were made for modified hematite and tools only. Measurements were taken to the nearest .1 mm using vernier calipers. Hardness was measured and coded by criteria similar to those used by House (1977: 138):

1 = Hardness < 2 1/2 – will leave a mark on paper
2 = Hardness > 2 1/2, < 5 1/2 – can be scratched by a knife but will not readily leave a mark on paper
3 = Hardness > 5 1/2 – cannot be scratched by a knife.

The categories technological class and shape class were designed to be conceptually similar to those used in the lithic analysis (Vol. II). Technological class therefore described the kind of modification (if any) that had been made on the raw material. It exactly corresponds to House's (1977: 134-135) "degree of modification" and was described as unmodified, rubbed, or tool. Tools were those pieces that were unquestionably shaped into usable forms, always as celts or axes in this sample, or were clearly fragments of such items. The term rubbed was applied to any piece that had one or more surfaces bearing evidence of smoothing or striating, or that was derived by flaking from a larger worked piece or was the larger worked piece from which flakes had been derived.

The shape class category further described modified pieces, either tools or rubbed pieces. All tools were classified as celts. They are long and narrow but usually fairly thick. Bit ends are wider than polls. Surfaces are smooth with the faces gently excurvate and converging at the sharp bit. Polls are rectangular with a flat end.

SELGEM # ______

Artifact # ______

00101 - State Missouri ______

00501 - County ______

01001 - Site Number 23 ______

02001 - S, E, or ST ______

02101 - Horizontal Provenience ______

02102 - Test Pit ______

02201 - Vertical Provenience ______

06001 - General Type Hematite ______

15001 - Color ______

21001 - M_1 (maximum length) ______

22001 - M_3 (maximum width) ______

22501 - M_4 (maximum thickness) ______

09001 - Technical class ______

He unmod ______

He rubbed ______

He tool ______

08001 - Shape class ______

unmod ______

tool - celt ______

flake ______

flaked piece ______

tab ______

prism ______

chunk ______

20001 - Count ______

Figure 3. SELGEM coding format for hematite.

Modified pieces that are not tools were identified as one of five forms: tabular pieces, prismatic pieces, flakes, flaked pieces, or chunks. The terms tabular and prismatic were derived from Kay's, et al. (1978) analysis of the hematite from Rodgers Shelter. Tabular pieces are flat, thin pieces with two flat, smooth surfaces and a thin edge that often is also ground. The plan view of the surfaces may be square, rectangular, or irregular. Prismatic pieces have three or more worked surfaces. They are normally long and narrow, but width and thickness measurements are similar. The worked surfaces may taper to a blunt point.

Flakes are morphologically identical to chert flakes. They possess a striking platform, a diffuse bulb of percussion, a dull luster on ventral surface, and they are almost always ground smooth on both the dorsal surface and the striking platform – indicating their derivation from a worked piece. Flaked pieces, conversely, are morphological identical to chert cores. They possess one or more negative bulbs of percussion and flake scars.

Finally, the term chunks refers to a variable class of items. They are irregularly shaped, but have at least one modified surface.

Overall, criteria for separation of classes of hematite artifacts are discrete and form a taxonomic structure modelled by the key shown in Figure 4. It should be noted that the classification is a formal classification. It is drawn directly from the sample of artifacts it classifies. It completely describes the Truman Reservoir hematite collections but does not necessarily form a descriptive system for hematite artifacts beyond this sample.

Description of the Collections

TOOLS

Only four specimens were identified as tools and all were further identified as celts or fragments of celts. All four tools are made of fine-crystalline specular hematite with a hardness greater than 5 1/2 on Mohs' scale. Lengths of two complete specimens are 60.3 and 80.6 mm, widths are 19.8 and 24.4 mm, and thicknesses are 23.8 and 21.8 mm. Weights were recorded as 57.1 and 190.7 gm, but the difference seems out of proportion to the differences in size.

MODIFIED? → no → Tech Class = He ummod.

↓ Yes

TOOL? → yes → Tech class = tool

↓ no → Tech class = He rub

BULB OF PERCUSSION
AND STRIKING PLATFORM? → yes → Shape class = flake

↓ no

NEGATIVE BULB AND
FLAKE SCARS? → yes → Shape class = flaked piece

↓ no

2 FLAT SURFACES, THIN
RELATIVE TO LENGTH AND WIDTH? → yes → Shape class = tab

↓ no

3 OR MORE SURFACES, THICK
RELATIVE TO WIDTH? → Yes → Shape class = prism

↓ no

IRREGULAR SHAPE BUT WITH AT LEAST
ONE MODIFIED SURFACE? → yes → Shape class = chunk

Figure 4. Hematite artifact key.

WORKED HEMATITE

A total of 95 pieces of hematite examined in this study had been modified but not to the extent that they could be considered as tools. This total includes 37 tabular pieces, 35 prismatic pieces, 11 flakes, 2 flaked pieces, and 10 chunks. Descriptive attributes of weight and size of these pieces are summarized in Table 1. Descriptive statistics include the range, mean, and standard deviation. However, a simple inspection of all data suggested that most distributions were considerably skewed to the left (that is, considerably more pieces with sizes less than the mean). Therefore, in order to more adequately portray size distributions, the first, second and third quartiles are also given (the Q_1, Q_2 or median, and Q_3 respectively). As a less skewed measure of variability about the median, the semi-interquartile range (Q) is also presented. (The semi-interquartile range, or quartile deviation, is an average of the values between the first and third quartiles and is thus more stable than the standard deviation when extreme values are present [Blalock 1960: 65]).

Tabular and prismatic pieces of hematite are generally small; ranges, quartiles, and semi-interquartile ranges reflecting the presence of only a few large pieces in each class. The extremely small size of many of these pieces and the fact that all edges are generally well-smoothed, except for the triangular base of the prismatic pieces, suggests that many of these may be spent or nearly so for the further production of pigment.

Flakes are also normally very small. Morphologically, most of them most closely resemble bifacial trim flakes with their highly acute lipped striking platform angles, ground and or faceted striking platforms, and small size.

The two flaked pieces, while both meeting the general definitional criteria for a flaked piece, are actually quite different from one another. The smaller of the two is essentially a bifacial core which is fairly flat, but with the faces meeting in an edge from which flakes have been driven. The larger flaked piece would have a chipped stone analogy in a tabular core – that is, one that is a slab of rock from which flakes have been driven.

The chunks are definitionally irregular. Many are similar to chert shatter in that they are roughly cubical with no positive bulbs of percussion or striking platforms. In the case of the hematite pieces, at least one surface has been modified. The other chunks, including the one very large piece (1121.7 gm), are amorphous pieces of ore that clearly have been modified, usually in a preliminary fashion.

TABLE 1

Descriptive Attribute Summaries

	Minimum	Maximum	$\bar{X}$	s	Q_1	Med.	Q_3	Q	n
			WEIGHT (gm)						
Tabular	.1	122.6	24.6	30.5	3.8	10.5	37.9	17.1	37
Prismatic	1.0	46.5	8.8	9.5	2.1	4.7	12.8	5.4	35
Flakes	.6	56.3	7.0	16.5	.7	1.2	3.2	1.3	11
Flaked pieces	90.6	158.7	-	-	-	-	-	-	2
Chunks	1.5	1121.7	155.3	342.6	4.4	44.2	120.3	58.0	10
			LENGTH (mm)						
Tabular	9.4	63.0	34.1	15.4	23.1	30.9	44.8	10.9	37
Prismatic	11.0	35.3	22.0	7.7	16.6	20.5	25.2	4.3	35
Flakes	8.2	54.5	18.6	13.7	10.2	13.0	21.5	5.7	11
Flaked pieces	62.3	76.7	-	-	-	-	-	-	2
Chunks	14.6	119.0	46.5	30.4	30.8	44.3	52.7	11.0	10
			WIDTH (mm)						
Tabular	7.6	52.5	24.9	11.0	17.2	23.5	32.2	7.5	37
Prismatic	8.2	30.3	16.0	5.9	12.0	14.0	18.9	3.4	35
Flakes	10.9	58.3	20.6	13.8	13.8	14.8	20.2	3.2	11
Flaked pieces	54.5	54.5	-	-	-	-	-	-	2
Chunks	6.8	91.9	31.3	24.2	18.2	27.5	38.2	10.0	10
			THICKNESS (mm)						
Tabular	3.2	23.5	9.2	4.9	6.0	7.9	10.8	2.4	37
Prismatic	4.4	28.5	11.7	5.5	7.9	11.0	14.8	3.5	35
Flakes	4.1	13.0	6.0	2.5	4.6	5.3	6.3	.9	11
Flaked pieces	14.5	20.0	-	-	-	-	-	-	2
Chunks	7.4	56.5	21.0	14.5	13.6	16.75	26.1	6.3	10

UNMODIFIED HEMATITE

The most numerous category of hematite was that of unmodified hematite and comprised of 164 specimens. Pieces are of all manner of shapes and sizes. Weights range from .1 to 247.8 gm with a mean of 32.78 gm and a standard deviation of 49.54. Like all weight distributions, that for unmodified hematite is skewed to the left and we therefore additionally present positional statistics: $Q_1 = 2.2$, median = 7.1, $Q_3 = 45.7$, Q = 21.8.

Quite clearly the majority of the pieces of unmodified hematite are also small. Unmodified hematite may have been introduced to a site in one of several ways. Unmodified pieces of raw material, especially the larger pieces, could be raw material procured for manufacture but, for some reason, never used for either pigment or tool manufacture. Smaller pieces could represent similar behavior or could be accidental inclusions. Since hematite outcrops in the limestones in the eastern part of the reservoir in particular, it is present in stream gravels and probably in residuum. It is not difficult to imagine small pieces of hematite clinging to wet stream cobbles or in the dirt matrix surrounding freshly unearthed chert nodules, in either case being inadvertently introduced into a site.

Raw Material Selection

At the beginning of this paper, four types of hematite were described: ordinary hematite, specular hematite, red ochre, and limonite. A brief consideration is given here to the possible differential use of these four types of raw material.

Table 2 cross-tabulates the frequencies of the four types of hematite with the seven types of artifacts we have described: tools, tabular pieces, prismatic pieces, flakes, flaked pieces, chunks, and unmodified pieces. While all four are represented in the collections, ordinary hematite is in fact far more numerous than any other type of hematite, accounting by itself for 88.2% of all specimens. Red ochre and limonite, conversely, account for only seven (2.7%) of the specimens and are all unmodified pieces of material. Specular hematite accounts for the other 9.1% of the specimens and includes all the tools.

A chi-square test of the use of hematite for different artifact forms (excluding the unmodified pieces, and therefore red ochre and limonite which have no cases when unmodified pieces are removed) suggests a non-random use of raw material for different forms ($X^2 = 32.82$, DF = 5, $p < .001$). The greatest departures from random, however, are attained by tools and chunks of specular hematite.

TABLE 2

Hematite Type by Artifact Type

	Tool	Tabular	Prism	Flakes	Flaked	Chunk	Unmodified	Total
Hematite	0	31	33	11	2	5	150	232
Specular	4	6	2	0	0	5	7	24
Red Ochre	0	0	0	0	0	0	1	1
Limonite	0	0	0	0	0	0	6	6
Total	4	37	35	11	2	10	164	263

TABLE 3

Hardness by Artifact Type

	Tool	Tabular	Prism	Flakes	Flaked	Chunk	Unmodified	Total
1	0	1	3	0	0	0	12	16
2	0	29	28	2	1	5	100	165
3	4	7	4	9	1	5	52	82
Total	4	37	35	11	2	10	164	263

Possibly of greater relevance to raw material selection and use is the hardness of the material. Table 3 therefore cross-tabulates frequencies of the three hardness categories (<2 1/2, 2 1/2-5 1/2, >5 1/2) by the seven artifact types. Soft material is relatively uncommon, comprising only 6.1% of the specimens. Medium and hard hematite are considerably better represented, accounting for 62.7% and 31.2%, respectively.

Examining the use of materials of varying hardness for different purposes suggests again a non-random use of raw material for different purposes. Specifically, tools, flakes, and chunks are over-represented in the hardness >5 1/2 class. It is highly likely that all three of these are technologically related. House (1977: 139-141) suggests that at least two of the three celts she examined in the Stage 2 survey collections had been roughed out by chipping. This could easily account for the presence of flakes and chunks, some of which resemble shatter, in the collections. As for tools, we are uncertain whether hard material was selected because it chipped better (which seems unlikely) or because it had other properties that were desirable. The hardness would definitely be advantageous if the tools were actually used. Whether or not they actually were used in chopping or related tasks is questionable, however.

Spatial and Temporal Distributions

The hematite described in this report is contained in either surface or excavated collections from 87 sites, including 32 Stage 1 survey sites, 29 Stage 3 survey and 1978 resurvey sites, 13 sites excavated or resurveyed in 1977, and 13 of the Fristoe Burial Mounds. The frequencies of pieces of hematite collected at each of these sites are given in Table 4 and the distribution of the sites themselves is shown in Figure 5.

The sites are clearly spread throughout the reservoir and are not necessarily confined to the area near the known hematite sources. The key, however, is the phrase known hematite sources. The best source of information on hematite occurrence in the reservoir area is Broadhead's (1880) description; however, this survey was entirely on the lands owned by one Major R. H. Melton and those lands were entirely in southern Benton and northern Hickory counties. The predominant bedrock in this area is the Jefferson City, and it is therefore this formation that we often consider to be the major source of hematite. However, Branson (1944: 399) lists a type of hematite that

> includes a number of deposits of earthy, red, and some blue, specular hematite occurring in lenses

TABLE 4

Frequency of Occurrence of Hematite in Truman Reservoir Sites

Site No.	Tools	Tabular Pieces	Prismatic Pieces	Flakes	Flaked Pieces	Chunks	Unmodified Pieces	Total Number of Pieces
			Stage 3 Survey and 1978 Resurvey					
23BE111	-	-	1	-	-	-	-	1
23BE166	-	-	-	-	-	-	1	1
23BE204	-	-	-	-	-	-	1	1
23BE318	-	-	-	-	-	-	2	2
23BE388	-	1	-	-	-	-	-	1
23BE397	-	-	-	-	-	-	1	1
23BE432	-	1	-	-	-	-	-	1
23BE681	-	-	-	1	-	-	-	1
23BE694	-	-	-	-	-	1	-	1
23BE698	-	-	-	-	-	-	1	1
23BE699	-	-	-	-	-	-	2	2
23BE704	-	-	-	-	-	-	1	1
23BE713	-	1	-	-	-	-	-	1
23BE714	-	-	1	-	-	-	-	1
23BE715	-	-	-	-	-	-	1	1
23BE730	1	-	-	-	-	-	2	3
23SR169	-	-	-	-	-	-	2	2
23SR189	-	-	-	-	-	-	1	1
23SR550	-	1	-	-	-	-	-	1
23SR671	-	-	-	-	-	-	1	1
23HE8	-	1	1	-	-	-	1	3
23HE183	-	-	-	-	-	1	-	1
23HE213	-	-	1	-	-	-	13	14
23HE396	-	-	-	-	-	-	1	1
23HE593	-	-	-	-	-	-	2	2
23HE597	-	-	-	-	-	-	1	1
23HE598	-	-	-	-	-	-	2	2
23HE616	-	1	-	-	-	1	-	2
23HE622	-	1	-	-	-	-	-	1
			Excavation and 1977 Resurvey					
23BE207	-	-	-	-	-	-	2	2
23BE241	1	-	-	-	-	-	-	1
23BE318	-	2	-	-	-	1	-	3
23BE336	-	2	-	-	-	-	-	2
23BE337	-	3	3	2	-	-	20	28
23BE579	-	-	1	1	-	3	9	14
23BE614	-	-	-	-	-	-	1	1
23BE660	-	5	4	1	1	-	13	24
23BE662	-	-	4	-	-	-	8	12
23BE676	-	1	1	-	-	1	7	10
23SR632	-	-	1	-	-	-	5	6
23HE368	-	-	-	-	-	-	2	2
23HE412	-	-	-	-	-	-	1	1

TABLE 4: Continued

Frequency of Occurrence of Hematite in Truman Reservoir Sites

Site No.	Tools	Tabular Pieces	Prismatic Pieces	Flakes	Flaked Pieces	Chunks	Unmodified Pieces	Total Number of Pieces
				Stage 1 Survey				
23HI218	-	1	-	-	-	-	-	1
23BE289	-	1	-	-	-	-	-	1
23BE345	-	-	-	-	-	-	2	2
23BE347	-	-	-	-	-	-	1	1
23BE358	-	-	1	-	-	-	-	1
23BE367	-	-	1	-	-	-	-	1
23SR136	-	1	-	-	-	-	-	1
23SR140	-	1	-	-	-	-	1	2
23SR284	-	-	-	-	-	-	1	1
23SR288	-	-	1	-	-	-	-	1
23SR424	-	1	-	-	-	-	-	1
23HE114	-	-	-	-	-	-	3	3
23HE120	-	-	1	-	-	-	3	4
23HE122	-	1	-	1	-	-	2	4
23HE168	-	-	-	-	-	-	1	1
23HE180	-	-	-	-	-	-	2	2
23HE187	-	-	1	-	-	-	-	1
23HE190	-	1	-	-	-	-	1	2
23HE205	-	-	-	-	1	-	-	1
23HE211	-	-	-	1	-	-	-	1
23HE218	-	1	-	-	-	-	-	1
23HE224	-	-	-	-	-	-	1	1
23HE228	-	1	-	-	-	-	-	1
23HE243	-	-	-	-	-	-	1	1
23HE244	-	-	-	-	-	-	3	3
23HE245	-	-	-	-	-	-	2	2
23HE248	-	-	-	-	-	-	1	1
23HE252	-	1	-	-	-	-	1	2
23HE261	-	-	1	-	-	-	2	3
23HE269	-	-	-	-	-	-	1	1
23HE284	-	-	-	-	-	-	3	3
23HE490	-	-	-	-	-	-	2	2
				Mounds				
23HI18	1	-	-	-	-	-	-	1
23HI30	-	3	4	4	-	3	8	22
23HI30A	-	1	-	-	-	-	4	5
23BE6-1	-	-	3	-	-	-	3	6
23BE6-2	-	-	1	-	-	-	1	2
23BE117	-	1	-	-	-	-	-	1
23BE118	-	-	-	-	-	-	10	10
23BE128	-	1	1	-	-	-	-	2
23BE136	-	-	1	-	-	-	1	2
23SR138	1	-	-	-	-	-	-	1
23CE123	-	-	-	-	-	-	1	1
23CE148	-	1	-	-	-	-	-	1
23PO307	-	-	1	-	-	-	-	1

TABLE 5

Use of Hematite by Periods

Age of Component	Tools	Tabular and Prismatic Pieces	Flakes and Flaked Pieces	Chunks	Unmodified Pieces
Early and Middle Archaic	-	1	1	-	3
Late Archaic	-	1	-	-	1
Woodland	-	2	-	1	7
Multicomponent	-	1	-	1	7
Late Archaic and Woodland	-	7	4	2	4
Unknown	2	27	2	2	24

> and nodules in the basal member of the Pennsylvanian system, usually where that system lies unconformably upon the older rocks. Deposits of this type are therefore confined to a relatively narrow strip of country following the margin of the Pennsylvanian rocks.

This strip following the margin of the Pennsylvanian should pass through the Truman area and in fact, should pass through Henry County. This could account for the large amount of hematite found on Henry County sites. Certainly inhabitants of the sites in Henry County could have been exploiting hematite sources to the east. Ray (Vol. II, Pt. 4) found that significant amounts of chert from 23HE9 were those that would have had to have been procured from, at closest, the Benton County-Hickory County area and it is reasonable that hematite could have been procured at the same time. It is also the case, however, that both Pennsylvanian age rocks and the underlying Mississippian age rocks are exposed in the valley walls, thus the unconformity between them would also be exposed and, according to Branson, should provide another source of hematite. Ray (ibid.) found a predominant use of the local Mississippian cherts at 23HE9, and it is reasonable that hematite could have also been procured from this source.

In sum, therefore, hematite, like cherts and clays, is used throughout the reservoir and was probably available pretty much throughout the area. These findings correspond with those of House (1977) for the Stage 2 Truman Reservoir survey.

Temporally, it is somewhat more difficult to discuss the use of hematite. This is so for three reasons: (1) the lack of any kind of diagnostic material to date many of the sites; (2) the crudeness of the dating available for many of the other sites; and (3) the apparent multicomponent nature of some sites and the impossibility of assigning the hematite to its correct component.

Temporal data are available for some sites, and though problematic, may be summarized as in Table 5. The data clearly suggest use of hematite nearly throughout the prehistoric sequence, although they provide no evidence of differential use through time. This is not entirely consistent with the evidence from Rodgers Shelter where over 79% of the hematite recovered was from the Middle Archaic components (McMillan 1976). McMillan (1976: 230) has noted that "sparse hillside cover and erosion [during the Middle Archaic] would have provided optimal conditions for securing [hematite]." While this is true, it is also the case that hematite is represented in the Late Archaic in percent nearly equal to that during the early Middle Archaic and that McMillan (1976: 226) has interpreted the succeeding Woodland occupation, in which hematite

is notably lacking, as that of a series of transient settlement stations. Pigment processing may well not be expected in such a site type. Our data suggest that hematite procurement and processing continued as an important activity in the Truman Reservoir subsequent to the Middle Archaic period. The evidence for this is the repeated occurrence of hematite on open sites with Late Archaic and/or Woodland components, as well as the presence of hematite in some quantity in the Fristoe Burial Mounds.

The Uses of Hematite in the Western Missouri Ozarks – Synthesis and Comparisons

In spite of the rather frequent occurrence of hematite in the Truman Reservoir collections, its uses are not diverse; they consist entirely of celts and rubbed pieces, in addition, of course, to unmodified lumps of hematite. Additionally, it has been suggested that hematite occurs on sites throughout the prehistoric period in the Truman Reservoir and is not temporally restricted. In this section, we briefly compare the uses of hematite in the Truman area with that in the wider midwest.

A survey of the literature suggests that the Truman Reservoir uses of hematite are somewhat more restricted than for the Midwest in general. The finding of unmodified lumps of hematite and the rubbed pieces is common. However, a wider range of tool forms or ornaments occurs. Celts, as appear in the Truman area, are a common artifact. A hematite adz was found in the lowest level of Graham Cave (Logan 1952: 50, 74), and a single ax occurred in Horizon 6 at the Koster Site in Illinois (Cook 1976: 81). At least one of the ground stone celts from the Ferry Site in southern Illinois appears from the illustrations (Fowler 1957: 7, 25) to have been made of hematite, although raw material is not specified. Hematite celts, while not considered numerous, are nevertheless listed as a trait of Adena (Webb and Snow 1945: 88).

However, an additional variety of artifacts are also made of hematite at sites beyond the Truman vicinity. Plummets made of hematite occur in Horizon 6 at Koster (Cook 1976: 77, 81), at the Godar and Elm Point sites, also in the lower Illinois Valley (Titterington 1950: 22, 24), and in Mound 7 of the Pete Klunk mound group (Perino 1968: 79). Beads of hematite appear at Modoc Rock Shelter (Fowler 1959: 60) and Horizons 4 and 6 at Koster (Cook 1976: 44, 77, 81). Hemispheres of hematite occasionally occur at Adena sites (Webb and Snow 1945: 89). These sites thus clearly reflect a somewhat more varied use of this mineral than is reflected in the Truman Reservoir sites, including Rodgers Shelter and Phillips Spring.

A rapid survey of the literature also suggests that hematite use is most common during the Middle through Late Archaic periods. It has already been noted that McMillan (1976: 225) finds hematite processing to be a major activity at Rodgers Shelter during the Middle Archaic occupation of 7000-6300 B.P. The majority of the Modoc Rock Shelter hematite occurs in strata projected to have dated 6500-4500 B.P. (Fowler 1959: 37). These dates are consistent with the dates of 5730±95 and 5440±100 to 5070±90 B.P. for the Horizon 6 occupation at Koster (Cook 1976: 70). These same dates should also apply to the Godar Site. A second modal occurrence of hematite use occurs a millennium or so later. Hematite was processed at Phillips Spring between 4000 and 3000 years ago, in Horizon 4 at Koster where a radiocarbon date of 3950±75 B.P. has been obtained (Cook 1976: 65), and in strata at Modoc that are projected to date around 3500 B.P. based on artifact similarities. Similar dates should apply to the Elm Point and Booth (Klippel 1969) sites, the latter of which is an open habitation site containing evidence for hematite processing, and to the Sedalia sites in Pettis County at which relatively extensive hematite processing is also reflected (Kerry McGrath, personal communication).

We have examined the Woodland literature for the same part of the country and find relatively little use made of hematite. To be sure, red ochre was often found covering the bones of burials, particularly during the so-called Red Ochre Phase (Cole and Deuel 1937) and occasional hematite fragments are found, but no substantial use of hematite occurs subsequent to the Archaic period. The Truman area therefore is something of an exception. We are reasonably certain of the Woodland temporal provenience of at least some of our hematite. Even granting the presence of multicomponent sites, surface finds occur relatively often with Woodland remains and the evidence from excavated context is clear. Vehik (1978: 99) has also described hematite from clear Late Woodland context in the western Ozarks. Additionally, however, the presence of hematite in burial mounds leaves no doubt of its late use in the Ozarks. Denny (1964: 94) also reports "numerous pieces of rubbed and unrubbed hematite" in the Boone Focus mortuary sites in Boone County.

Summary and Conclusions

Hematite follows only chert and clay in abundance of use of minerals in the eastern United States. Hematite is an ore of iron, comes in several varieties, and occurs in some quantity in the Ozarks of Missouri, including that portion in the vicinity of Truman Reservoir. A large quantity of worked and unworked hematite has been collected during recent investigations in the Truman Reservoir. Worked forms may be either rubbed or worked into celts. Sites

with hematite are distributed throughout the reservoir and seem to occur throughout time, unlike the majority of hematite-yielding sites in the Midwest in which hematite use is largely a Middle and Late Archaic phenomenon.

Author's Note

Margaret A. Van Ness supervised the field laboratory during the summer of 1977 and the Columbia laboratory during academic year 1977-1978. Following the precedent of her predecessor, Deborah House, she analyzed the hematite collected during the summer of 1977. She left the project prior to the 1978 field season, however. Subsequently, while hematite was routinely separated from other raw material classes, it was not analyzed. At the end of the project, Roper therefore described the undescribed material, analyzed all collected data, and wrote this report. Because Van Ness had described a large amount of the material and had compiled a very useful series of notes on hematite use in the Midwest, her name has been added as co-author. All responsibility for the contents and interpretations in this paper, however, must rest with the senior author.

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PART IV.

LITHICS STUDIES

NUMBER 1.

LITHIC LABORATORY PROCEDURES MANUAL

OVERVIEW OF THE ANALYSIS

The work of the lithic laboratory is designed to accomplish several major goals. These goals are overlapping in most cases so that the data are collected for more than one user. In order to accomplish the collection of data in a uniform way, a central theme for viewing the lithic artifacts was selected. All demands for data are then transformed into some expression of the central theme.

In this case, the lithic reduction sequence is the central theme. This reduction sequence is defined as all of the steps necessary to produce a stone tool, from the recognition of the need for a tool to the tool's final discard. In general terms this includes:

1. conceptualization of need
2. procurement of raw material
3. various steps of manufacture
4. use
5. modification after wear
6. breakage
7. modification after breakage
8. discard

A number of general research objectives have been identified by various staff members of the Harry S. Truman Project. These include:

1. a description of all the lithic materials recovered during survey in 1979 and excavated materials from 1977, 1978 and 1979;
2. a description of the lithic technological subsystem of a representative number of sites from within the Reservoir area;
3. an understanding and description of the variation in lithic inventories between sites and between various time/culture boundaries;
4. a description of the available lithic resources in the project area;
5. a definition of tool assemblages from various time periods;
6. an identification of use and wear patterns.

The data collected in the lithic laboratory are used to fulfill all of these research objectives as well as to assist those who are writing site reports by providing basic descriptions and counts of classes of artifacts.

The lithic artifacts are described as members of three separate analytic sub-systems: first, the technological attributes of lithic reduction; second, the morphological attributes of tool form using reduction in shape and edge reduction to produce working edges as major themes; and third, attributes of edge reduction by use or wear. This manual, however, covers only a minor part of the use/wear analysis since it is essentially a separate analysis whose attributes were not coded by all laboratory personnel.

PROCEDURE

General Instructions

1. Check field notes.

2. Fill out a 3 x 5" index card for the site file if there is not yet one for that site. It should include the following information:

Site number (upper left hand corner)
Field number
Public use area name — upper right hand corner
Any provenience data from bag

The following on appropriately numbered lines:

1. List artifact numbers of pulled artifacts processed. [Pulled artifacts are points, hematite, ground stone, pottery, historic materials. These are generally boxed separately.] Include in this space points and point bases from survey which will be bagged separately and pulled for analysis. Use only for artifacts actually handled.

2. Total number of artifacts processed.

3. Artifact numbers and/or range of artifact numbers processed, e.g., 39627-40119 or T1-T97.

4. Artifact numbers of missing artifacts. (This includes pulled artifacts not actually handled.)

5. Artifact numbers of renumbered artifacts (number after renumbering).

6. General comments.

7. Comments on functional analysis.

3. Tech Sheets

Category 00501 - write out in full the name of county.
Category 02001 - S-surface, E-excavated, St-shovel test.
SELGEM number - This number is taken from the master file catalogue sheets on materials previously classified. If the artifact has not previously been numbered, leave this space blank. The SELGEM number serves as the artifact number for 1979 artifacts.

Artifact Number -

1 - 499 Old number used to catalogue prior to 1978.
500 - 909 Used for numbering new artifacts for sites where some numbers from 1-499 already exist or to renumber duplicates.
1000 - Reclassified artifacts or artifacts numbered before 1979.
2000, 3000 - Field artifact numbers from 1978.
X1 - Xnth - Numbers assigned to debris 1979.
T1 - Tnth - Numbers assigned to materials from shovel tests 1979.

Raw Material

RAW MATERIAL, COLOR (15001)

Under the SELGEM system, raw material and color are two aspects of a single category. On the current coding sheets these aspects are recorded in different places, although they must be coordinated. Their treatment differs depending on the raw material being coded.

I. Chert

Chert is always placed in the raw material blank on lithic coding forms. When chert is the raw material, colors are listed in the color column.

II. Lithic, non-chert, culturally modified items

Stones such as quartz, quartzite, jasper, etc. which have been knapped in the same way as the chert are handled as follows:

A. In the color column list
   1. the type of stone, e.g., quartzite
   2. the color or colors.
B. Analyze as for chert artifacts.

III. Lithic, non-chert, unmodified items

Unmodified stone such as sandstone, limestone, fire cracked rock, miscellaneous rock, hematite, limonite, quartzose, etc. are handled as follows:

A. List type of stone in the color column; do not list the color.

B. List the stone type in the tech and shape columns and do not analyze further.

C. If there are several pieces of limestone, etc. and if they have not been assigned separate SELGEM numbers, list them together under one artifact number. Enter the number of pieces in the comments column as 20001 or enter the

appropriate information on a Number 1 sheet. Where provenience data exist, use #1 sheets. Use tech sheets for surface collections.

IV. Ground stone

Although these items are culturally modified, the production process is not covered by the analytic system used for the chert. Therefore, they should be treated as in III above, i.e., ground stone in color, tech and shape columns, and no further analysis. Each ground stone item should have a unique artifact number. If the ground stone is a known tool type, e.g., mano, put the tool name after ground stone in both the tech and shape columns.

V. Non-lithic material

Non-lithic materials should not be coded on the same code sheets as lithic materials. To code ceramics, bone and other such material change General Type (06001) to the appropriate item, e.g., bone or ceramic. Enter the appropriate provenience information at the top of the page. Enter the SELGEM and/or artifact number in the appropriate columns, and enter bone, etc. in the tech and shape columns. For ceramics, distinguish historic ceramics from prehistoric ceramics and code them accordingly. All of the aboriginal ceramics in the Truman Reservoir area should be coded as prehistoric ceramics.

COLOR CODING (15001)

For all chert items enter the colors in the following order:

1st - predominant color
2nd - second most dominant color

All color names should be written in full, except for designations such as light and dark. Light may be abbreviated as L and dark as D. Periods should not be used with these abbreviations.

Examples of colors used:

grey - L grey, D grey
white
brown
tan
beige
buff
yellow
red
pink
purple

orange
blue
green (rare)
black

NOTE: There will be many variations, including if necessary such terms as lavender, wine, brick, and salmon.

CHERT TYPE (16001)

Chert Name	Code As:
Warsaw	Warsaw
Burlington	Burl
Pierson	Pierson
Jefferson City	JefCit
Roubidoux	Roubi
Gasconade	Gascon
Chouteau	Chou
Florence	Flor
Nehawka	Neh
Keokuk	Keok
Kimmswick	Kimms
Peoria	Peoria
Foraker	Fora
Three Mile	Three
Cresswell	Cressw
Crescent	Cresc
Indeterminate	Ind
Indeterminate Mississippian	Ind Miss
Indeterminate Ordovician	Ind Ord
Indeterminate Exotic	Ind Exo
Indeterminate Mississippian Exotic	Ind Miss Exo
Indeterminate Ordovician Exotic	Ind Ord Exo
Indeterminate Small (when less than 2 on size card)	Ind S

See Figure 1 for identification key; characteristics of oolites are listed in Table 1, and chert type definitions are summarized in Table 2.

SOURCE (16501)

	Code As:
River cobble with cortex	Riv
Nodule with cortex	Nodcort
Nodule without cortex	Nod
Tabular with cortex	Tabcort
Tabular without cortex	Tab
Indeterminate	Ind
Secondary weathering	Secon
Cortex	Cort

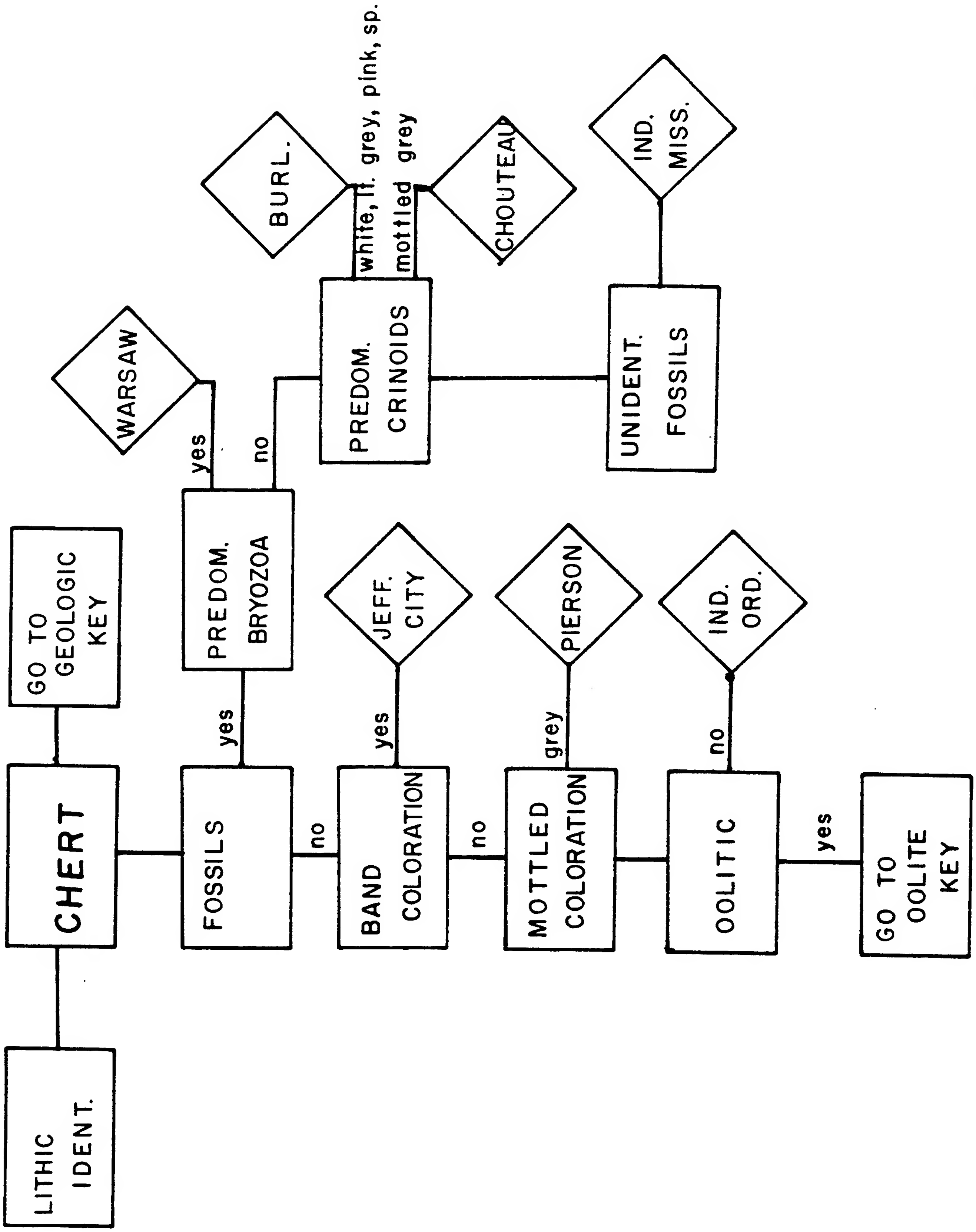


Figure 1. Chert identification key.

TABLE 1

Oolite Key

	Jefferson City	Roubidoux	Gasconade
Size	small (.6 mm)	large (.6-.8 mm)	?
Sandcentered	+	+	-
Fractured	+	+	-
Rind	-	+	-
Sharp interface	+	-	-

+ = present
- = absent

TABLE 2

Chert Type Definitions

Warsaw
- Mississippian
- Can be pinkish, darker grey than Burlington
- Mottled, speckled
- Bryozoa predominant fossil
  - Spines
  - Hexactonella
  - Algal colonies
- Crinoids fewer than Burlington
- Brachiopods

Burlington
- Mississippian
- White to a light buff or grey color
- Highly fossiliferous
- Crinoids predominant fossil; can also have bryozoa and brachiopods
- Coarse to fine grained texture
- Sometimes exhibits a speckled appearance
- Heat treatment turns it to a light pink

Pierson
- Mississippian
- Resembles Burlington
- Tannish, reddish, bluish, brown, grey, mottled
- Can have both bryozoa and crinoids; mostly spines
- Tends to be hashy at high magnification, but not always
- N.B. If specimen is crinoidiferous, suspect Chouteau rather than Pierson.

Chouteau
- Mississippian
- Light and dark mottled grey matrix with a prominent white cortex
- Fossiliferous - including in order of frequency:
  - Bryozoa
  - Crinoids
  - Brachiopods
- Coarse to fine grained texture
- Sometimes exhibits a blocky structure
- Heat treatment turns it to a light pink or faded grey and emphasizes the contact area between the matrix and cortex.

TABLE 2: Continued

Chert Type Definitions

Jefferson City

Ordovician
Color usually varies from light to dark: blue, brown, grey and white
It is often concentrically banded in cross section
It may be mottled
Fossils are scarce to totally absent; when present, they are only crinoid ambrulachral plates
Druse is common; quartzose is also found
Can be oolitic (sometimes densely); oolites may be sand centered and have a sharp interface with the matrix Jefferson City;oolites are usually small and do not have rinds.
Fine grained (except quartzose) and "smooth" texture
Commonly occurs in ellipsoidal nodules
Heat treatment turns it to a light to dark pink and bleaches the darker colors to greys and purples

Roubidoux

Ordovician
Wide range of colors
May be mottled or banded
Oolitic; oolites large (.6-8 mm), sand centered, fractured, rinds
Quartzose common
Sand grains
Druse (Quartz crystals)
Sandy chert

Gasconade

Ordovician
Grey, blue banded; may be mottled
Oolitic; oolites not translucent, have no rinds, no sharp interface, no sand centers
Druse (Quartz crystals)
Ostracods (big bean-shaped discs)

The Analysis of Flakes

FLAKE ORIENTATION AND TERMINOLOGY

Flakes are described using the standard terms shown on Figure 2. The orientation of flakes is based on the location of the bulb or ripple marks indicating the presence of the bulb of force or direction of the force used to remove the flake.

For example, on a hypothetical flake one could describe the area of retouch as occurring on the proximal end or the dorsal left lateral edge. BE AS SPECIFIC AS POSSIBLE.

Broken flakes can be described using the same terms plus the terms necessary to describe the kind of break.

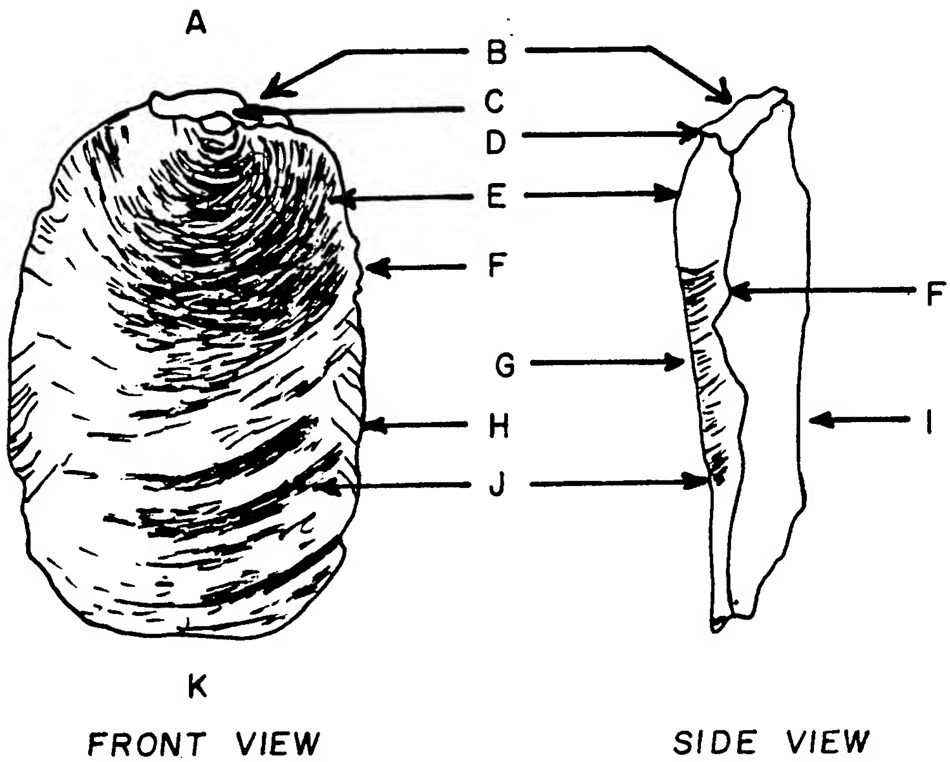
BREAKAGE PATTERNS (07001)

	Code As:
Flakes	
Broken - for unidentifiable fragments	Brok
Intact	Int
Broken, proximal end remains	Brok Prox
Broken, distal end remains	Brok dist
Broken, medial segment	Brok med
Size grading for broken flakes is coded in shape class	Flake Frag ____
Tools	
Distal end	Distend
Proximal end	Proxend
Lateral segment	Lateral
Medial segment	Medial
Longitudinal segment	Longseg
Transverse segment	Transeg
Complete	Complete
Partial	Part
Incomplete	Incomplete

Orient according to Figure 3.
See Figure 4 for breakage determination.

HOW TO TAKE FLAKE AND/OR TOOL MEASUREMENTS

Seven measurements may be taken on an intact flake or a complete tool. These include the maximum length (M_1), length of axis of force (M_2), width (M_3), thickness (M_4), bulbar edge angle (A_1), working edge angle (A_2) and unworked edge angle (A_3).



A = Proximal end

B = Striking platform

C = Point of impact

D = Lip

E = Bulb of percussion

F = Lateral edge

G = Ventral surface

H = Feathering

I = Dorsal surface

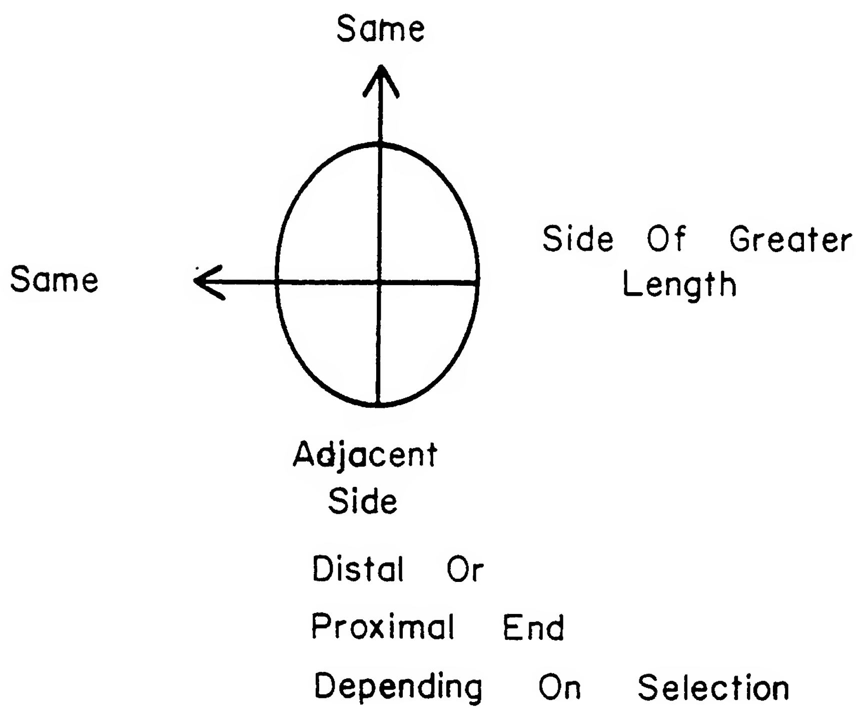
J = Ripple mark

K = Distal end

Figure 2. Front and side view of flakes.

ORIENTATION OF TOOLS

The distal and proximal ends are those sides adjacent to the sides of greater length.



If further observations are necessary, choose a proximal end and mark it with the symbol ↑ , pointing to the proximal end.

Figure 3. Orientation of tools.

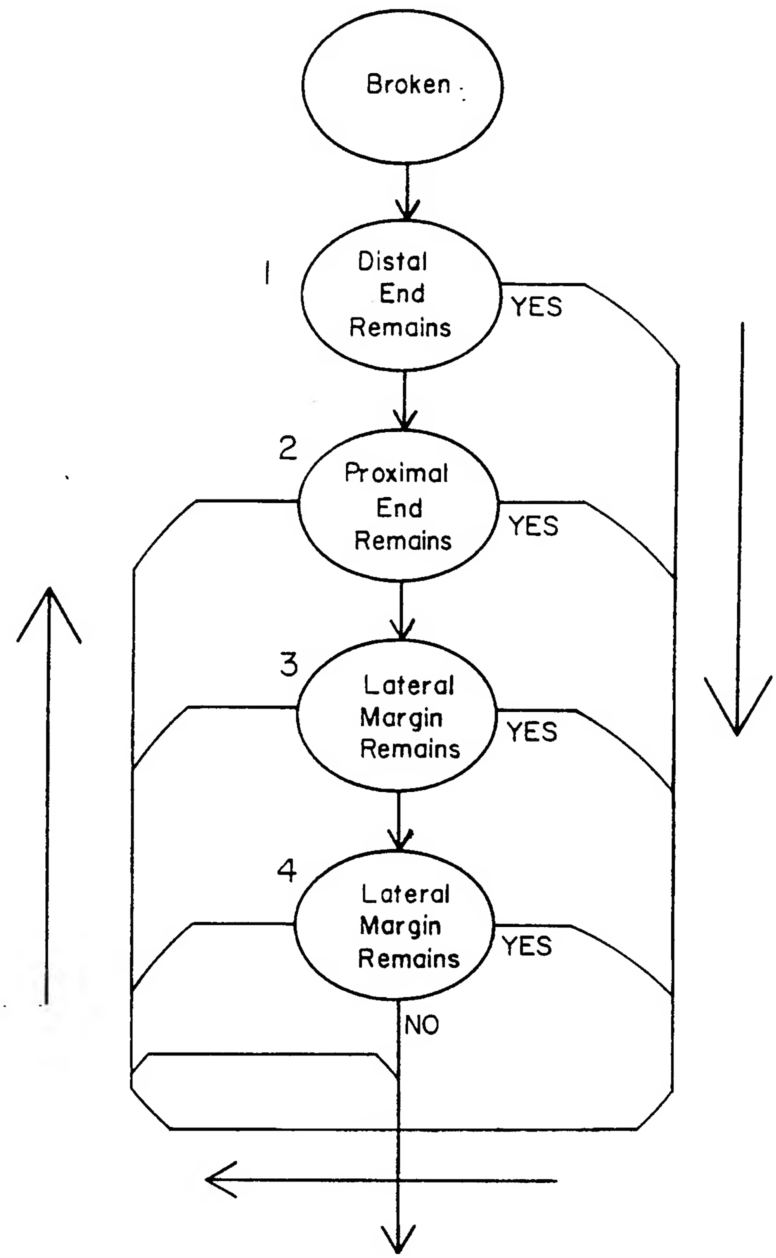


Figure 4. Flake breakage key.

The first of these, the maximum length, is taken by placing the platform of the intact flake parallel and adjacent to one of the caliper arms and then measuring the length from this position (Fig. 5a). For a complete tool, the distal to proximal orientation (each end parallel to the caliper arms, the side parallel to the caliper bar) provides the maximum length. To measure the length of axis of force (on intact flakes only), place the striking area against the caliper arm and visualize a line of force which runs medially through the bulb of percussion and continues to the flake edge. Place this edge opposite the striking area on the other caliper arm and measure.

The width (M_3) is simply a measurement taken by placing the platform perpendicular to the caliper arms, parallel to the caliper bar. The thickness (M_3) consists of the widest dorsal to ventral measure.

The M_1-M_4 measurements are read as four digit numbers to the nearest tenth of a millimeter. Thus one centimeter is listed as 0100, ten centimeters as 1000, etc.

The A_1-A_3 measurements consist of three digits. The bulbar edge angle (A_1) is measured on a bulbar angle chart for intact flakes and for complete tools with bulbs of percussion remaining. Place the bulbar platform parallel to the e-w axis (0° line), abutting the n-s axis (90° line) at the intersection of these two axes (Fig. 5b). Then take a reading just at the base of the bulb of percussion to note the angle at which the flake was struck. (Reading below the base of the bulb allows one to avoid confusing the angle of force with the bulbar protrusion). Record a reading of 85°, for example, as 085.

A_2, the working edge angle, is unique in that this measure must be taken on any utilized or retouched edge, whether on a complete or broken tool, or on an intact or a broken flake. To do this, place the goniometer against the worked edge and read from the hairline which intersects the numbers. A 45° angle is recorded as 045.

Take the last measure, that of the unworked edge angle (A_3), from unmodified distal ends of intact flakes using the goniometer as done for A_2. Do <u>not</u> measure the unmodified distal end of a broken flake.

Measurements

Maximum length (intact flakes and complete tools only)	M1(21001)
Length of axis of force (intact flakes only)	M2(21501)
Width (intact flakes and complete tools only)	M3(22001)

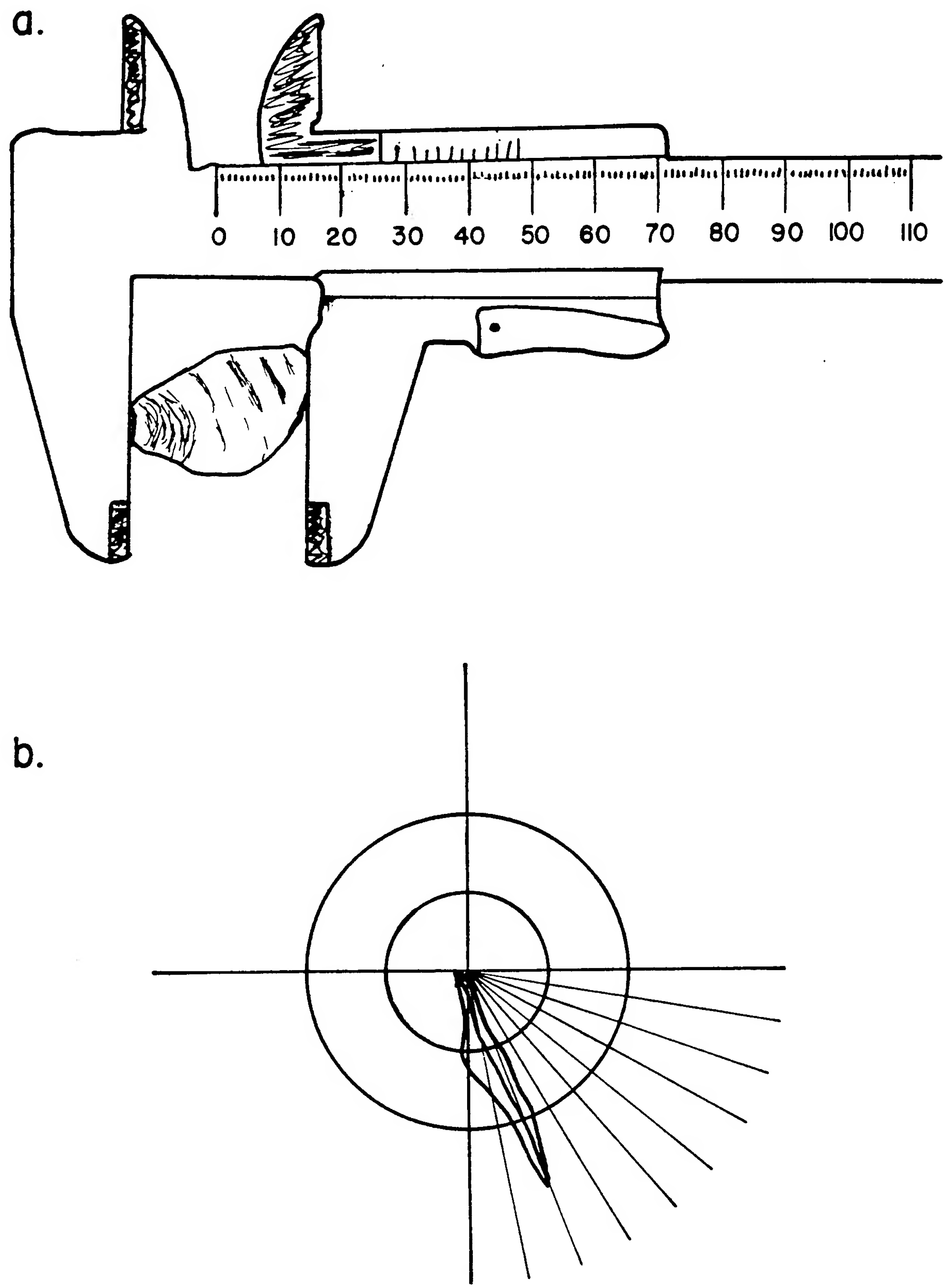


Figure 5. How to take flake measurements - a, linear; b, angular.

Thickness (intact flakes and complete tools only)	M4(22501)
Bulbar edge angle (on intact flakes and flake tools with bulb of percussion remaining)	A1(23001)
Working edge angle (measure for each defined tool, broken or complete)	A2(23501)
Unworked edge angle - distal end of flake when unmodified	A3(24001)

See Figure 6.

OBSERVATION OF EDGE REDUCTION

As shown on the key (Fig. 7), edge reduction is divided into three kinds. After an artifact has been described, the edges should be examined with a hand lens (10X) for evidence of edge reduction. Of interest here are three kinds of reduction which are the result of shaping or sharpening an edge by or for use. The following is a general guide for kinds of edge reduction.

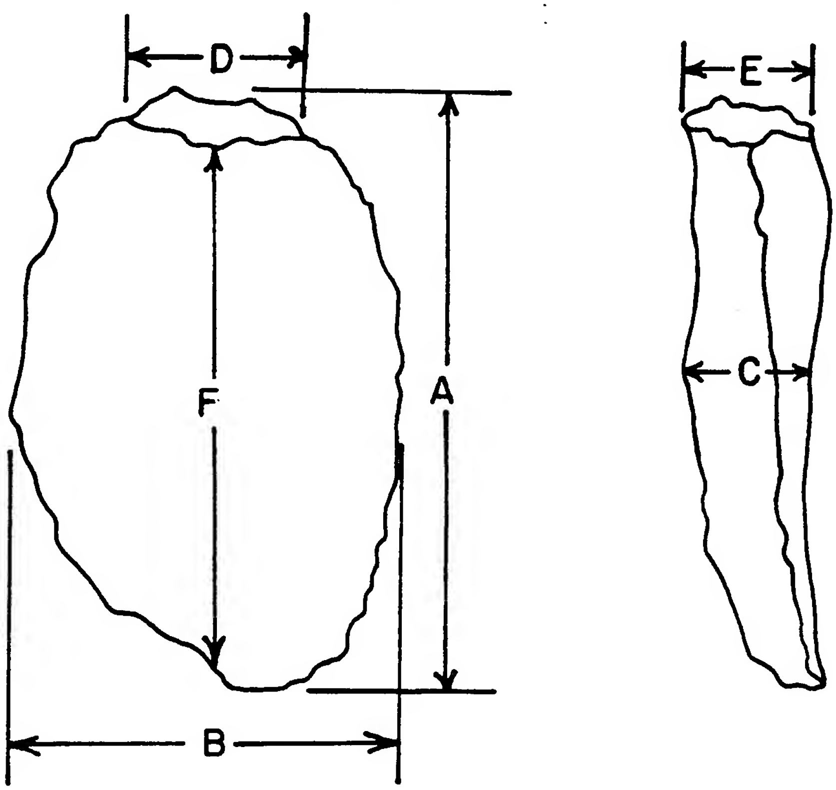
Purposeful Retouch

This is usually the result of fine pressure flaking or light hard hammer reduction. The edge is modified for cutting or scraping by altering the edge angle or edge shape. The best evidence is regularity in the flaking pattern.

Retouch scars differ from utilization scars by being larger, having sharper or more well defined edges, and by encroaching further over the face. Purposeful retouch may be found on edges other than the working edge. Code as RETOU.

Reduction by Use

This reduction is thought to be the result of the actual use of the tool. The edge damage noted should be small step fracture scars, random small flakes, sometimes crushing. Utilization scars are patterned, but are less regular than intentional retouch scars. They are smaller than retouch scars and have less well defined edges. They may have a variety of shapes such as scalar (fish scale shaped) or trapezoidal. They may feather out on the edges or they may be abruptly terminated (stepped). Utilization scars are found only on the working edges of the piece. Utilization scars are found on the face opposite the face that received the pressure of the task performed. For cutting tools, utilization scars will appear alternately on both faces. Utilized edges occasionally exhibit minor crushing. In these instances, the utilized edge feels



A = Max. flake length

B = Max. flake width

C = Max. flake thickness

D = Striking platform width

E = Striking platform length

F = Axis of force length

Figure 6. Measurements made of flakes, blades, and flake/blades.

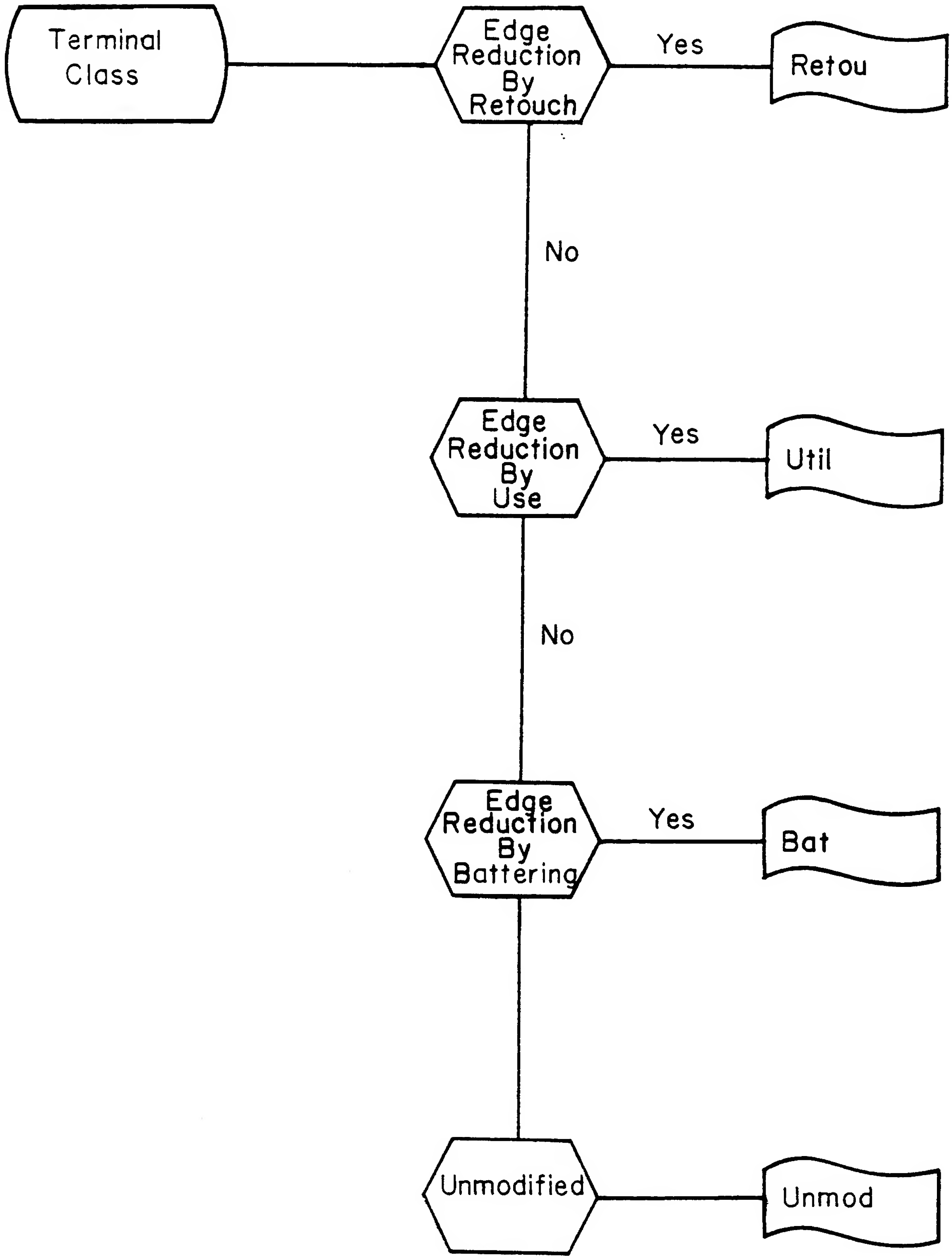


Figure 7. Key for edge reduction.

duller or more rounded than one would expect for an unmodified piece. Reduction by use is coded as UTIL.

Reduction by Battering

Battering is the result of being struck by or striking another piece of stone. The pitted surfaces often found on hammer and anvil stones are common examples of battering. Code as BAT.

Unmodified

All other artifacts without the above mentioned features are simply coded as unmodified. Code as UNMOD.

TRIM FLAKES

Definition: Trim flakes are tertiary flakes characterized by multiple flake scars on the dorsal face. The scars rarely include negative bulbs. The pattern of the scars suggests that the flakes came from bifaces, preforms, or other similarly worked tools.

TYPES OF TRIM FLAKES:

1. Trim Flake - A tertiary flake having multiple flake scars on the dorsal face but which does not retain any identifiable portion of the original edge, i.e., all edges feather out.

2. Biface Trim Flake - A tertiary flake having multiple flake scars on the dorsal face and which retains an identifiable portion of the original biface edge. The remaining edge is generally the striking platform. It resembles a faceted platform. In some cases, the original biface edge may be more extensive than the point of impact.

3. Uniface Trim Flake - A tertiary flake having multiple flake scars on the dorsal face and which retains an identifiable portion of the original uniface edge. The remaining uniface edge is generally the striking platform and may be more extensive than the point of impact.

	(09001) Tech Class	(08001) Shape Class If Not Tool Form
Flake tertiary retouched	Fl Tert Retou	Flake Retou **
Flake tertiary utilized	Fl Tert Util	Flake Util **
Flake tertiary unmodified	Fl Tert Unmod	Flake **
Flake secondary retouched	Fl Secon Retou	Flake Retou **
Flake secondary utilized	Fl Secon Util	Flake Util **
Flake secondary unmodified	Fl Secon Unmod	Flake **
Flake primary retouched	Fl Prim Retou	Flake Retou **
Flake primary utilized	Fl Prim Util	Flake Util **
Flake primary unmodified	Fl Prim Unmod	Flake **
Flake cortex retouched	Fl Cort Retou	Flake Retou **
Flake cortex utilized	Fl Cort Util	Flake Util **
Flake cortex unmodified	Fl Cort Unmod	Flake **
Trim flake retouched	Fl Tert T Retou	Flake Trim Retou **
Trim flake utilized	Fl Tert T Util	Flake Trim Util **
Trim flake unmodified	Fl Tert T Unmod	Flake Trim **
Biface trim flake retouched	Fl Tert BT Retou	Flake Bifac Trim Retou **
Biface trim flake utilized	Fl Tert BT Util	Flake Bifac Trim Util **
Biface trim flake unmodified	Fl Tert Bt Unmod	Flake Bifac Trim **
Uniface trim flake retouched	Fl Tert UT Retou	Flake Unifac Trim Retou **
Uniface trim flake utilized	Fl Tert UT Util	Flake Unifac Trim Util **
Uniface trim flake unmodified	Fl Tert Ut Unmod	Flake Uniface Trim **
Blade retouched	Bl Retou	Blade Retou
Blade utilized	Bl Util	Blade Util
Blade unmodified	Bl Unmod	Blade Unmod
Blade flake retouched	Blade Fl Retou	Blade Flake Retou
Blade flake utilized	Blade Fl Util	Blade Flake Util
Blade flake unmodified	Blade Fl Unmod	Blade Flake Unmod
Blade primary retouched	Blade Prim Retou	Blade Prim Retou
Blade primary utilized	Blade Prim Util	Blade Prim Util
Blade primary unmodified	Blade Prim Unmod	Blade Prim
Blade secondary retouched	Blade Secon Retou	Blade Secon Retou
Blade secondary utilized	Blade Secon Util	Blade Secon Util
Blade secondary unmodified	Blade Secon Unmod	Blade Secon
Blade cortex retouched	Blade Cort Retou	Blade Cort Retou
Blade cortex utilized	Blade Cort Util	Blade Cort Util
Blade cortex unmodified	Blade Cort Unmod	Blade Cort
Core cortex utilized	Core Cort Util	Core Util
Core cortex unmodified	Core Cort Unmod	Core
Core randomly flaked retouched	Core R Fl Retou	Core Retou
Core randomly flaked utilized	Core R Fl Util	Core Util
Core randomly flaked unmodified	Core R Fl Unmod	Core
Core prepared platform retouched	Core P Plat Retou	Core Retou
Core prepared platform utilized	Core P Plat Util	Core Util
Core prepared platform unmodified	Core P Plat Unmod	Core
Blade core	Core Blade	Core
Polyhedral core	Core Polyhedral	Core
Chunk	Chunk	Chunk
Potential raw material	Raw	Raw Material
Shatter	Shat	Shatter
Blank	Blank	Blank
Preform	Preform	Preform

**frag and size grade if applicable

N.B. Battered is also available as a Terminal class similar to Retou and Util. It should be coded as Bat, e.g. Flake tertiary battered FL Tert Bat.

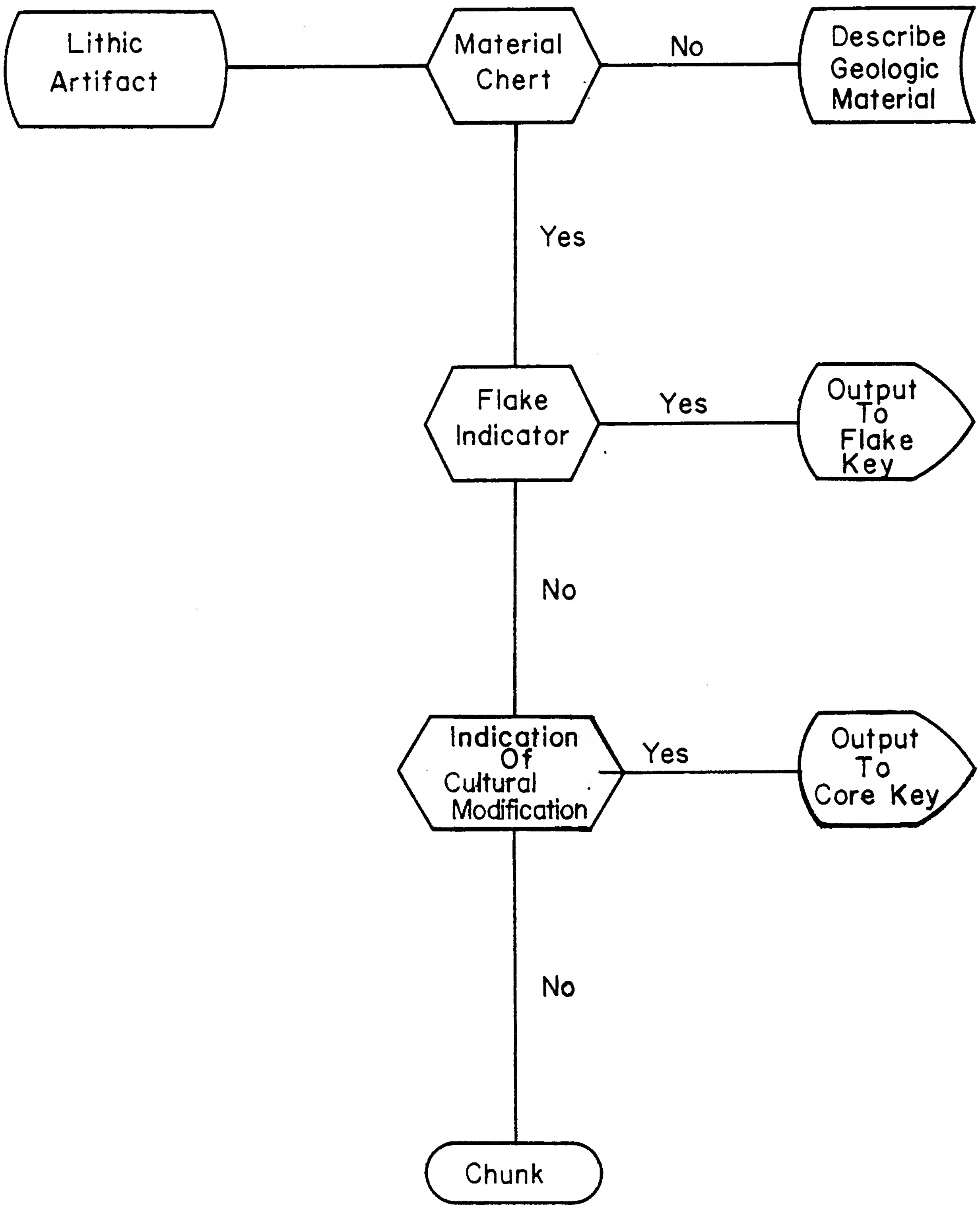


Figure 8. Key for major debris classes.

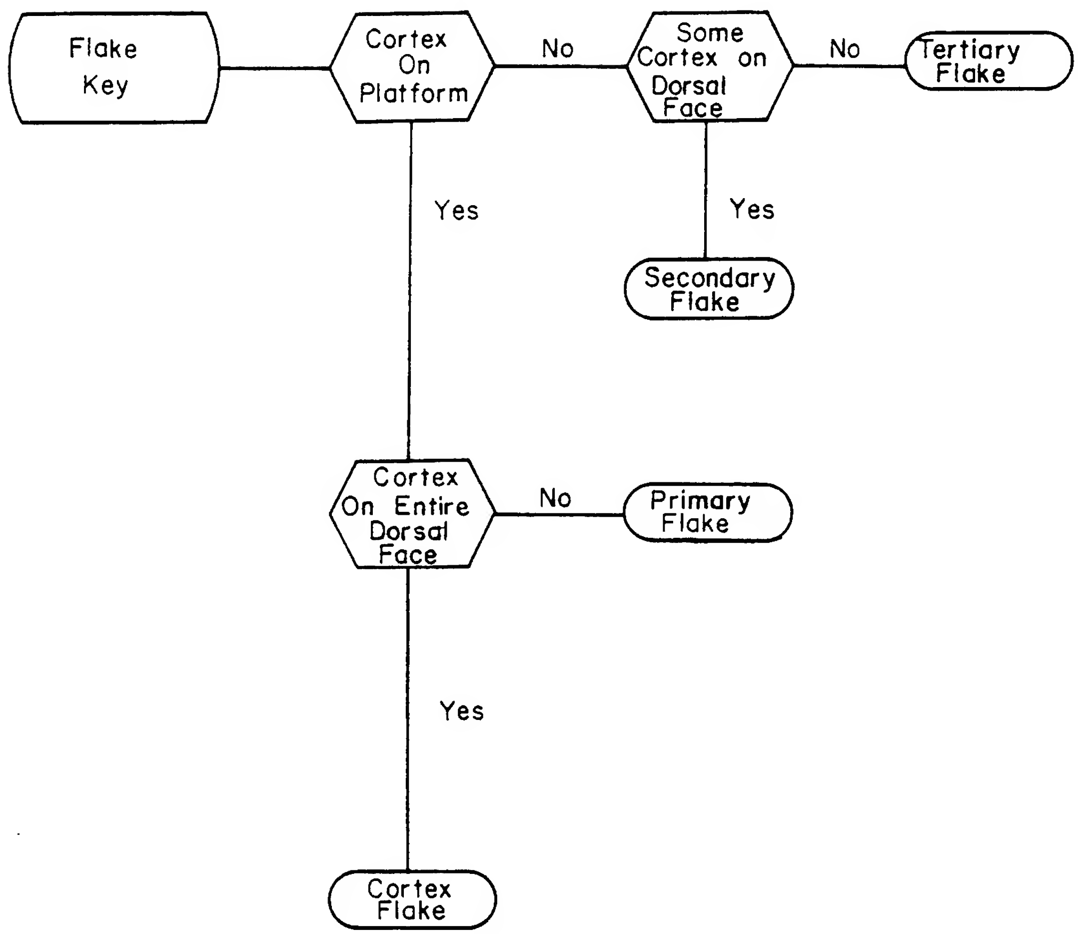


Figure 9. Flake key.

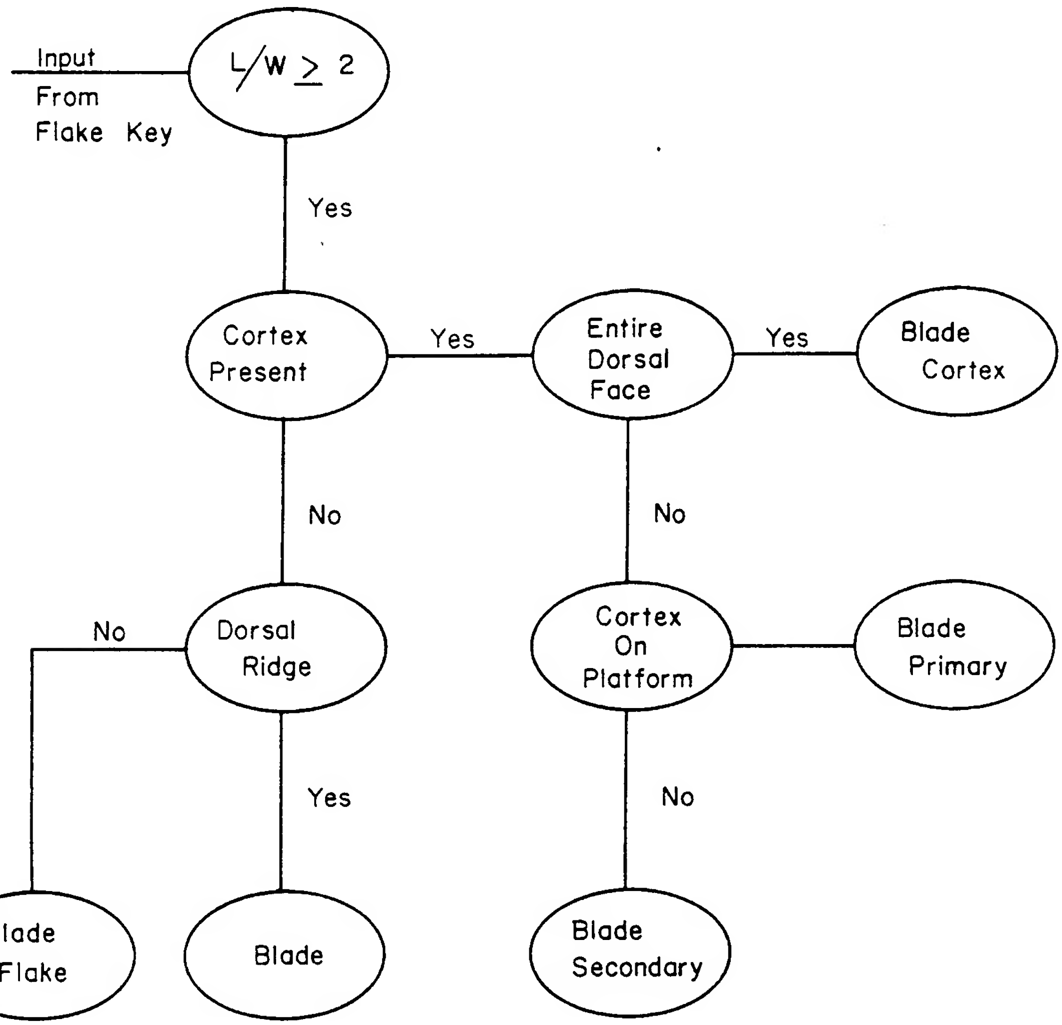


Figure 10. Blade key.

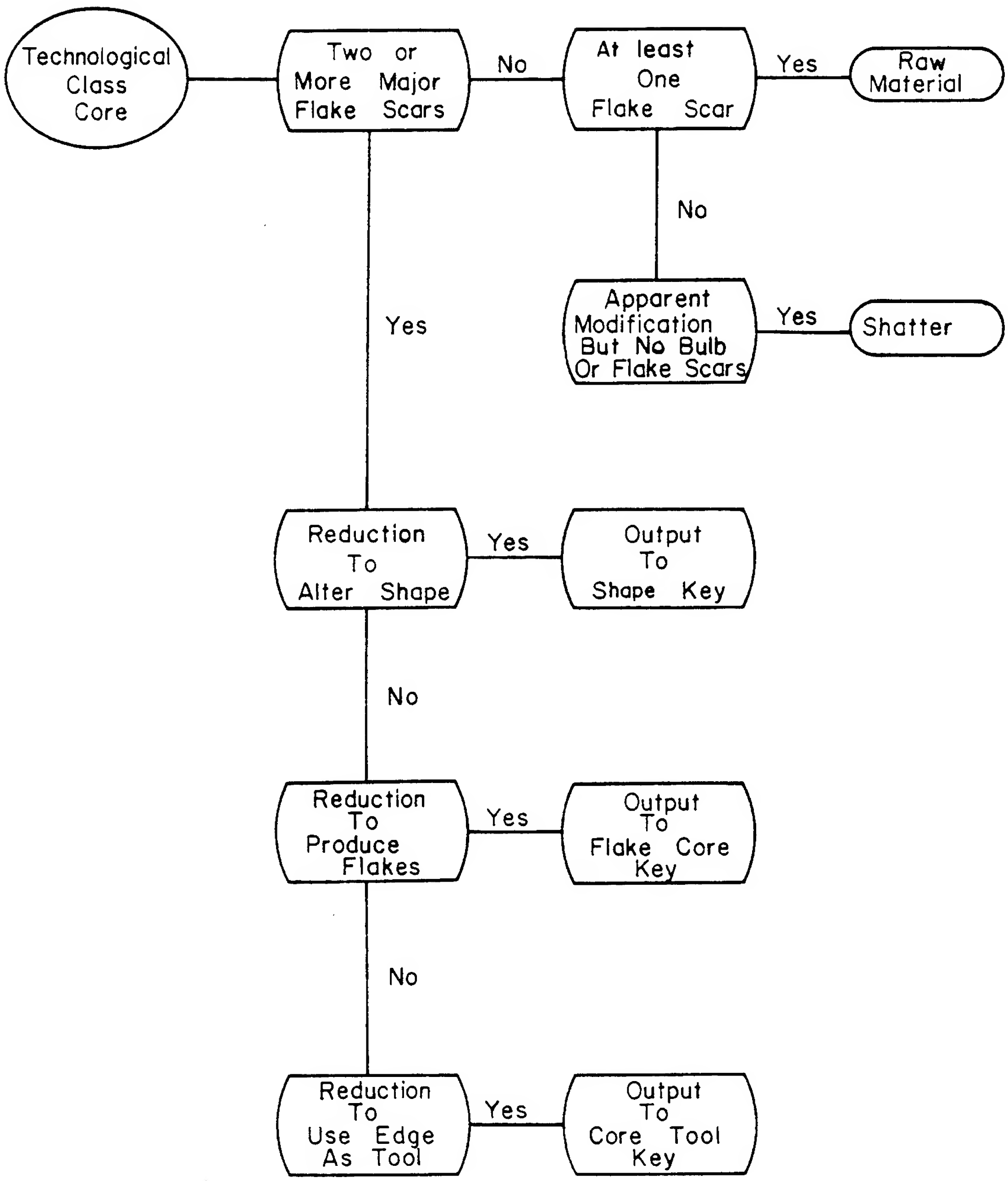
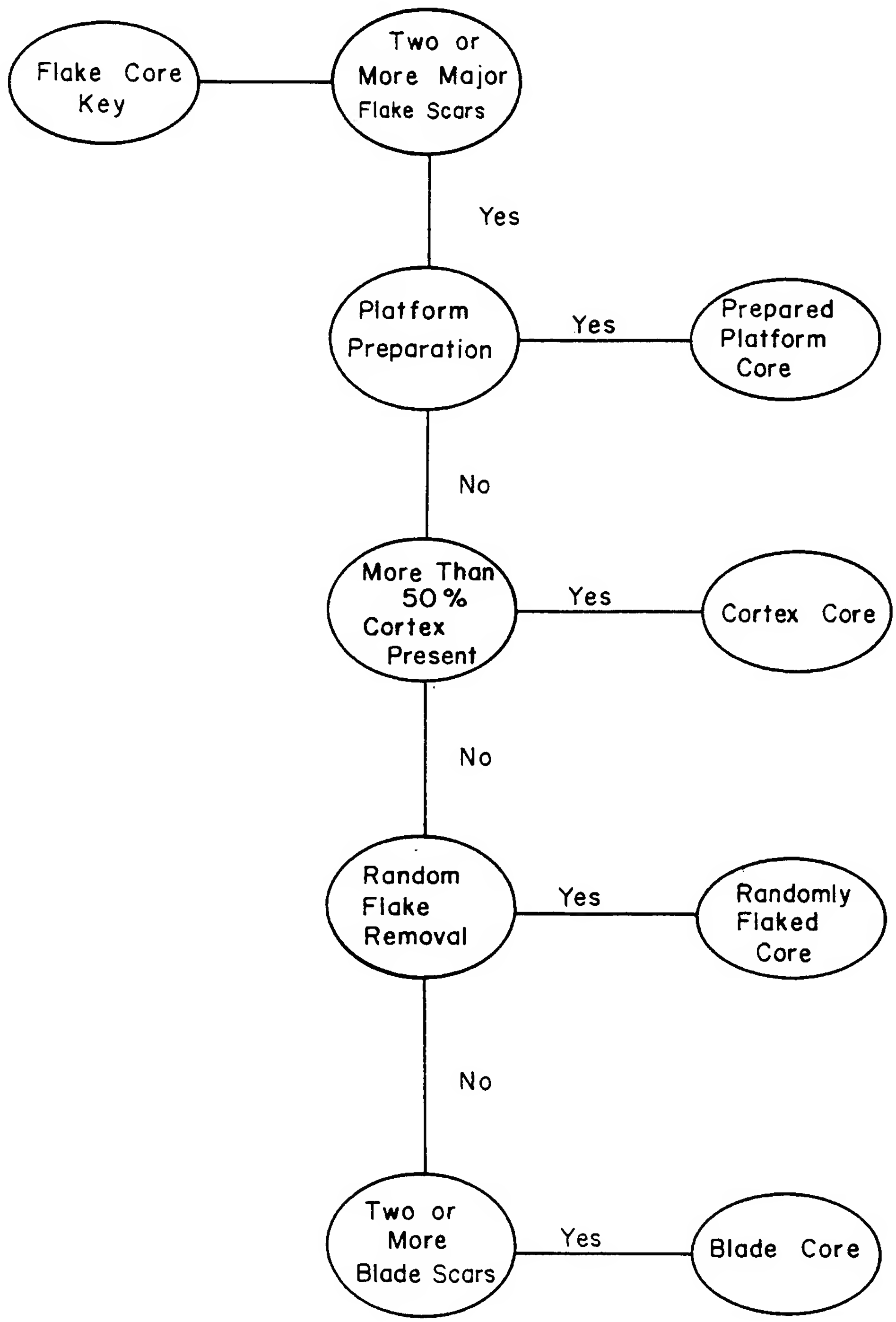


Figure 11. Core key.



Flake 12. Flake core key.

SIZE GRADING PROCEDURE FOR BROKEN FLAKES

Broken flakes are assigned a "Frag #" in the shape column. The number is assigned according to the number of the smallest box into which the fragment will fit completely. The sizes vary as follows:

1. 1.0 cm^2
2. 1.5 cm^2
3. 2.0 cm^2
4. 2.5 cm^2
5. 3.0 cm^2
6. >3.0 cm^2 (will not fit into #5 box)

All chert material 1.5 cm^2 (#2) or smaller may be considered too small for identification of chert type and may be coded "Ind S" in the chert column (16001). If a fragment is easily recognizable as to chert type but is less than 1.5 cm^2, code appropriate chert name.

The Analysis of Tools

BIFACIAL TOOLS

Complete Bifaces Without Steeply Beveled Edge

	(09001) Tech Class	(08001) Shape Class
Bifacial projectile point	Bifac	Bifac PJ
Biface circular	Bifac	Bifac circular
Biface rectangular	Bifac	Bifac rect
Biface bipointed	Bifac	Bifac bipoint
Biface acuminate	Bifac	Bifac acum
Biface triangular	Bifac	Bifac triang
Biface amorphous	Bifac	Bifac general
Biface ovate	Bifac	Bifac ovate

Broken Bifaces Without Steeply Beveled Edge

Non-transverse break	Bifac	Bifac Frag
Transverse break-pointed segment	Bifac	Bifac Frag Pt
Transverse break-squared segment	Bifac	Bifac Frag Sq
Transverse break-rounded segment	Bifac	Bifac Frag Rnd
Transverse break-irregular segment	Bifac	Bifac Frag Irreg

Broken Bifacial Projectile Points

Non-transverse break	Bifac	Bifac PJ Frag
Transverse break-basal segment	Bifac	Bifac PJ Frag Base
Transverse break-pointed segment	Bifac	Bifac PJ Frag Pt

See Fig. 13 for identification key.

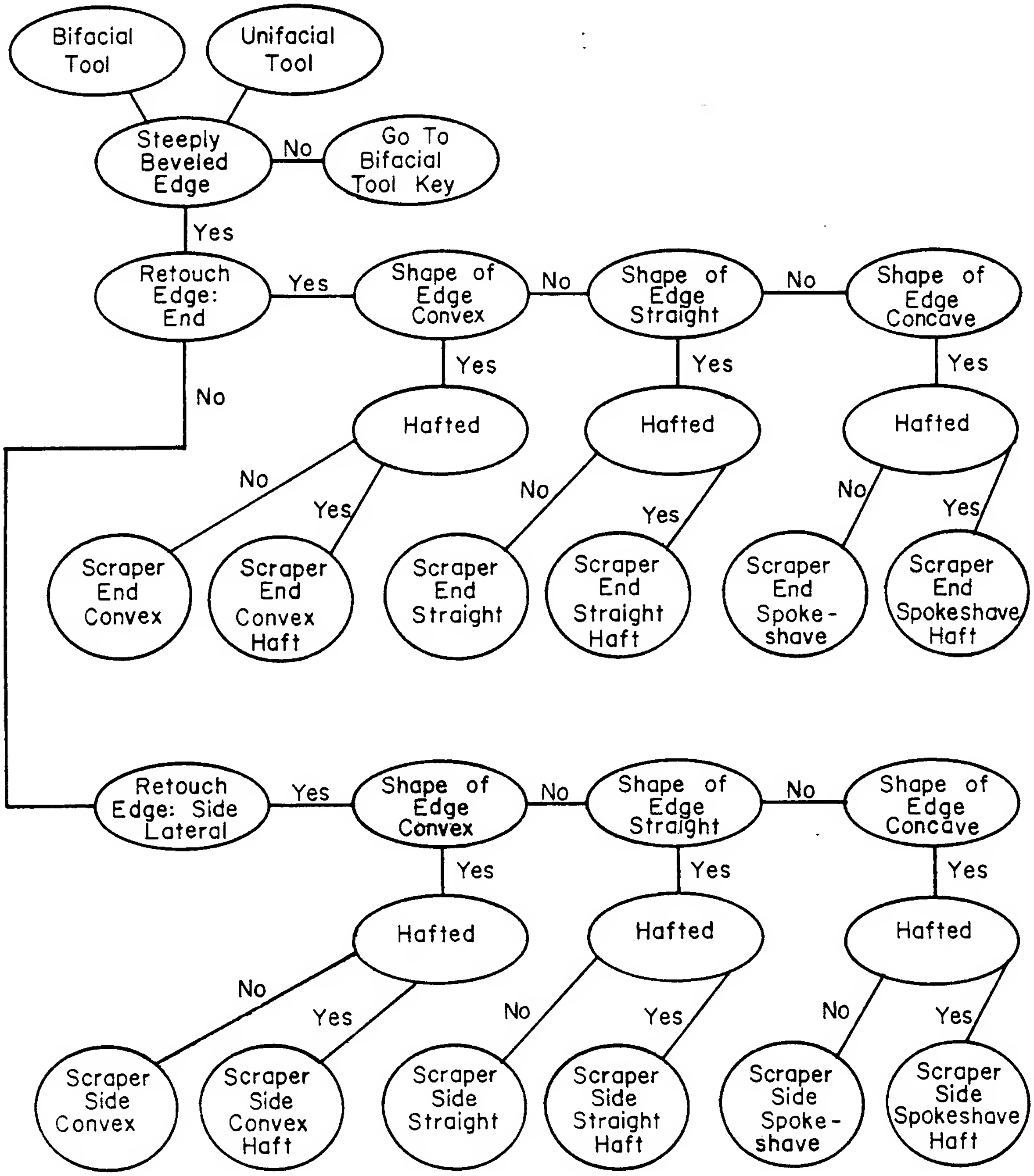


Figure 13. Bifacial tool key.

BIFACIAL OR UNIFACIAL TOOLS WITH STEEPLY BEVELED EDGE (SCRAPERS)

	Tech Class (09001)*	Shape Class (08001)
Scraper __ end convex		Scrap __ e conv
Scraper __ end convex haft		Scrap __ e conv h
Scraper __ end straight		Scrap __ e strai
Scraper __ end straight haft		Scrap __ e strai h
Scraper __ end spokeshave		Scrap __ e spok
Scraper __ end spokeshave haft		Scrap __ e spok h
Scraper __ end concave		Scrap __ e conc
Scraper __ end concave haft		Scrap __ e conc h
Scraper __ end notch		Scrap __ e notch
Scraper __ end irregular		Scrap __ e irreg
Scraper __ side convex		Scrap __ S conv
Scraper __ side convex haft		Scrap __ S conv h
Scraper __ side straight		Scrap __ S strai
Scraper __ side straight haft		Scrap __ s strai h
Scraper __ side spokeshave		Scrap __ s spok
Scraper __ side spokeshave haft		Scrap __ s spok h
Scraper __ side concave		Scrap __ s conc
Scraper __ side concave haft		Scrap __ s conc h
Scraper __ side notch		Scrap __ s notch
Scraper __ side irregular		Scrap __ s irreg
Scraper __ general		Scrap __ general
Scraper plane		Scraper plane

__ insert un (unifac) or bi (bifac) in blank

* Scrapers are technologically variable. They can be made on flakes, cores, shatter, or others. Therefore, there is no single tech class, so list the appropriate class.

See Fig. 14 for identification key.

MISCELLANEOUS TOOL FORMS

	Shape Class (08001)
Burin	Burin
Burin spall	Burin spall
Graver	Graver
Drill	Drill
Auger	Auger
Perforator	Perforator
Knife	Knife
Hoe	Hoe
Cleaver	Cleaver
Chopper	Chopper
Wedge	Wedge
Denticulate	Denticulate
Abrader	Abrader

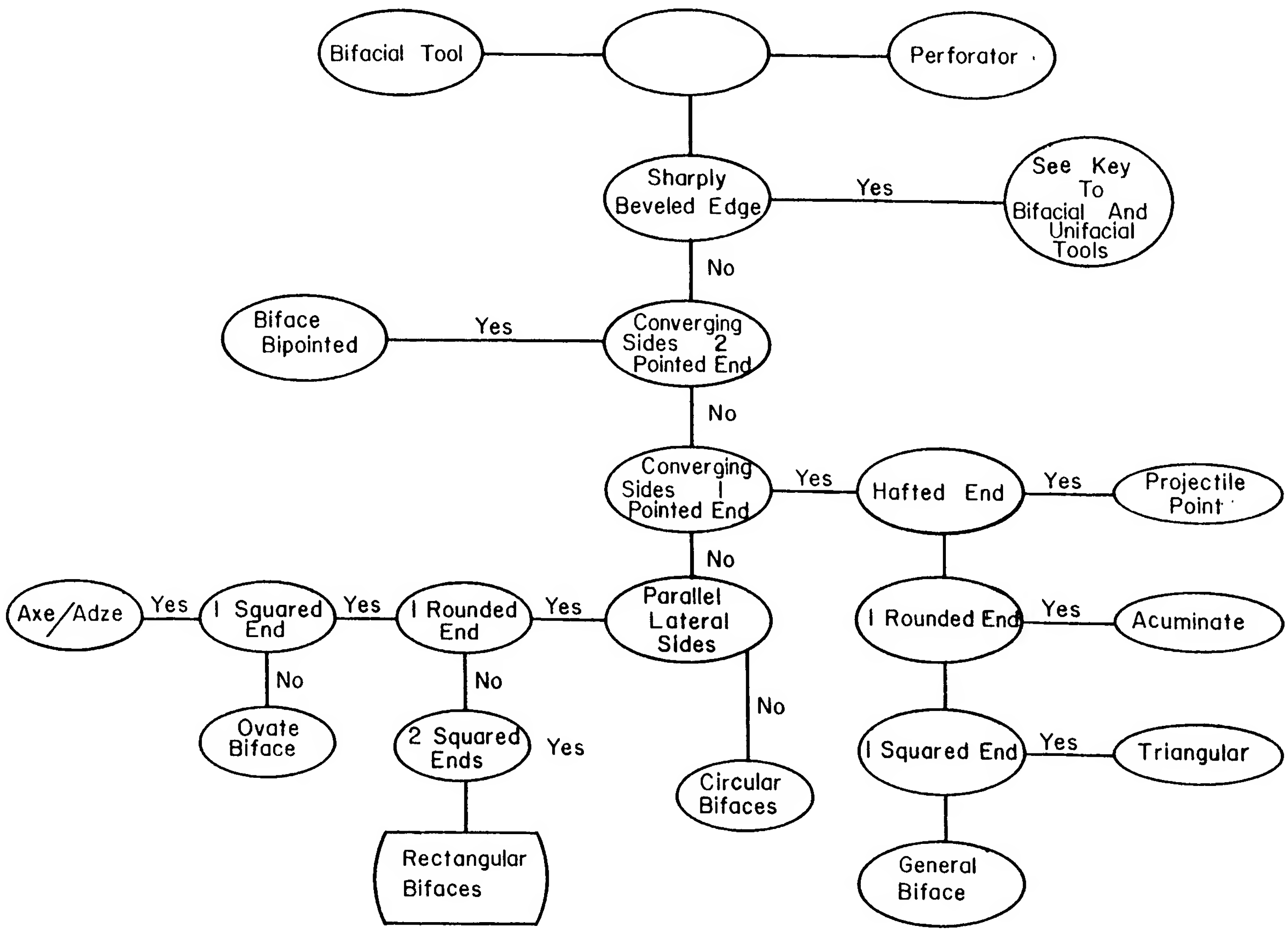


Figure 14. Key for bifacial, unifacial tools with steeply beveled edge.

Hammerstone	Hammerstone
Axe	Axe
Adze	Adze
Pitted stone	Pitted stone

The definitions of these classes follow.

Adze

The adze is a "well-made" symmetrical bifacial tool. One end is usually modified for hafting. The working edge is the distal end and is generally flat on one side and steeply bevelled on the other. Wear striations are vertical to the tool axis. Often this tool exhibits a rounded and well polished edge as well. Major attributes are:

1. elongated shape
2. bifacial retouch
3. steep sloped working edge
4. possible hafting zone
5. polish

Abrader

Soft stone, i.e., shale, sandstone, or limestone, used to shape or "sand" a softer material. The tool is characterized by v-shaped grooves and in some cases by more circular channels which result from rubbing the abrader on the material being abraded. Major attributes are:

1. geologic material, i.e., shale sandstone limestone, etc.
2. grooves or channels

Burin

Chisel-like implement derived from a blade or flake by removing one or more flakes parallel to the lateral margin of the original piece. Burins retain the negative bulbar scars from these flakes. As a tool, it is believed to have been used for incising with the flat working edge created by the flake removal on the working edge. Major attributes are: chisel-like working edge formed by transverse flake removal.

Burin Bit

A burin-like tool having a chisel-like working edge but lacking the transverse flake scar. They are formed on a corner or shoulder of a core or flake by taking advantage

of a natural break. The bit edge is backed by the tool body thereby making a strongly reinforced cutting edge. Major attribute is a chisel-like working edge formed by or on a natural break.

Burin Spall

The flake removed from a burin. It is thick in relation to its width and is usually triangular or rectangular in cross-section.

Cleaver

Hand size or larger chopping tool often backed on the edge opposing the working edge. The working edge is reduced to a cutting edge by bifacial edge reduction. The tool is not generally a biface but rather a large core-like piece with one or more chopping edges. Major attributes are:

1. hand size
2. bifacial working edge without fine retouching
3. use wear on working edge
4. backing

Note: may be confused with cores.

Denticulate

A lithic artifact with two or more tooth-like projections caused by snapping off of the distal or lateral margins. The appearance resembles a saw or tooth-like profile. Most frequently the artifact is a modified flake or blade. Its major attribute is a tooth-like profile created by edge modification.

Drill

A retouched bifacial tool characterized by a long slender pointed shaft. The shaft is generally round or oval in cross-section. Drills have well defined basal or hafted ends opposite the point. Drills are believed to have been used for rotary action penetration of organic materials. Major attributes are:

1. long slender pointed shaft with round or oval cross-section
2. basal expanded handle or hafted area.

Graver

A tool with one or more intentionally produced points or spurs. The points or spurs are relatively small. The points may be fortuitous. Gravers are found as individual

tools or on other tool forms such as scrapers. It is believed that gravers were used to incise soft materials or as short perforating tools. Major attributes are:

1. point or spur
2. some retouch on point or spur although wear indicators on a fortuitous point could qualify

Hammerstone

Primary tool for lithic reduction. Used for reducing chert or other flakable material. Hammerstones are generally hand sized. Within the reservoir most are chert river cobbles which show battering. Often broken fragments are found in the debris collections; they are sometimes confused with and classified as core fragments, however, the battered surface should be used as the major diagnostic attribute. Major attribute is battered facet(s).

Knife

A cutting or slicing tool defined primarily by the shape and angle of the working edge. The working edge is generally one of the lateral margins of the tool. These lateral margins are generally straight or only slightly curved.

The working edge angle is generally acute. Wilmsen's (1974:70) research infers most cutting functions from tools with working edge angles between 26° to 35°. He infers skinning from tools having edge angles ranging from 46° to 55°. Semenov (1964: 20) agrees with an acute angle definition. He reports a specific range only for whittling knives. These lie between 35° and 40°.

Knives may be bifacial or unifacial. Bifacial knives are generally finely retouched similarly to projectile points. Bifacial knives are generally lanceolate in form with some provision for hafting. The cross section is flat and lenticular. Unifacial knives are usually made on flakes. The flakes may be unmodified or slightly retouched. A common form of retouch is the backing of a knife. Unifacial knives in the Truman sample are generally wedge-shaped to triangular in cross section.

Perforator

A sharply pointed piercing instrument similar in shape to a drill but with little or no major retouch. Perforators were used for making holes in soft material. They differ

from drills or augers in the amount of retouch used to make the tool and in the sharpness of the point. That is, a perforator is used for piercing and a drill is used for making a hole by rotation of the tool. A drill point is generally more blunt while a perforator is sharply pointed. Major attributes are:

1. sharp point
2. minor, if any, retouch

Pitted Stone

A lithic artifact which generally displays one or more concavities with a conical cross-section. These concavities have battered edges and appeared to be formed as part of the process of using the artifact as an anvil.

Scraping Plane

A steeply chipped unifacial tool with a broad working edge opposed by a backed area used for holding or hafting. The basal element is often the ventral or internal surface of a large flake or core fragment and is essentially flat. This flat edge is used as a natural platform for resharpening. This tool may be confused with a cleaver or chopper, except that the scraping plane lacks a bifacial edge and shows little or no battering.

Wedge

A flake, core or piece of shatter, triangular in cross-section, with battering on the flatter section (opposite the point) resulting from being struck or driven into a softer substance. Sharp or pointed edge may show crushing or small hinged flakes.

Comments (30001)

This space is for general observations about the artifact that do not fit into the general classes of observations made in other categories.

I. In order of their appearance, the following observations should be made where applicable for individual artifacts:

1. WU wear or use indicates the item should be looked at with a microscope. Use with any item where you suspect utilization but are not sure enough to code as util.
2. HT indications of heat treatment present.

3. PH artifact of interest which may be photographed.
4. Special observations about context or other notable facts.
5. Any other comment.

Example: WU HT PH backdirt
NOTE: Leave a space between each comment.

II. In terms of an entire collection, the field number should be placed in the comments column for the first and the last artifact in the collection.

Procedure for Picking Up Collections

1. Number all

    1. Indeterminant chert
    2. Intact flakes
    3. Complete tools
    4. Incomplete tools
    5. Retouched and utilized flakes, shatter
    6. Cores

NOTE: Use Shape Class (08001) and Chert (16001) to number.

2. Pick up and bag separately in the following order:

    1. Indeterminant chert
    2. Broken flakes
    3. Shatter
    4. Retouched and utilized flakes (intact and broken)
    5. Unmodified intact flakes
    6. Complete and incomplete tools
    7. Retouched and utilized shatter
    8. Cores

NOTE: Use Shape Class (08001) to number.
Indeterminant chert <u>always</u> gets bagged separately no matter what it is.

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1974 <u>Lindenmeier: a Pleistocene hunting society</u>. Harper and Row, New York.

PART IV.

LITHICS STUDIES

NUMBER 2.

A STUDY OF CHERT RESOURCES IN THE TRUMAN RESERVOIR: AVAILABILITY, PROCUREMENT, AND UTILIZATION

by

Jack H. Ray

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank Michael J. Reagan for helpful suggestions during the project research, and I am especially grateful to Dr. Donna C. Roper for her advice, constructive criticisms, and comments on this paper.

ABSTRACT

An integrated study of the availability and prehistoric utilization of chert resources in the Harry S. Truman Reservoir area of southwest Missouri is described. The major kinds of cherts (Jefferson City, Chouteau, and Burlington) and the natural sources in which they occur are identified and described in detail. An intensive Chert Survey was conducted within delimited (1 km radius) territories around ten archeological sites throughout the reservoir to determine the availability of these different types of chert resources; predicted percentages of chert types expected to occur in site artifact collections were subsequently made. An economizing hypothesis, in which utilization was directly related to availability and proximity, was then tested by analyzing chert artifacts and debitage from site collections. The artifact analyses do not support the economizing hypothesis. The data suggest the actual utilization pattern involves chert quality as well as availability-procurement distance due to evidence of bias in chert use, usually for the better knapping quality Jefferson City chert. This study demonstrates that relatively accurate predictions of lithic utilization patterns within prescribed areas can be made from carefully controlled, intensive survey data on availability and quality. Lithic resource availability and utilization studies, such as this, have important implications for reconstructing prehistoric lithic technology subsystems, patterns of raw material procurement and exchange, and subsistence-settlement patterns.

A STUDY OF CHERT RESOURCES IN THE TRUMAN RESERVOIR: AVAILABILITY, PROCUREMENT, AND UTILIZATION

by

Jack H. Ray

INTRODUCTION

It has been correctly stated that the reconstruction of the lithic technology subsystem of a cultural system requires a good knowledge of the lithic resources which could have been used, those that were used, and a knowledge of the processes of procurement and distribution of those raw materials (House 1975: 81). This knowledge can best be obtained through an intensive study of the chipped stone resources in a particular area.

Sampling and identification of various chert resources in a study area are important not only for a better knowledge of the lithic technology subsystem, but it may be important for a better understanding of settlement patterns and social organization. It may be determined that the availability of good quality chert was an important consideration or the deciding factor in settlement location or, conversely, it may be found to have been unimportant if quality chert is ubiquitous in the area. Data on the nature, abundance, and availability of chipped stone resources is probably just as important as data on fauna and flora in interpreting site location. If it can be demonstrated through the identification of exotic cherts that trading was an important function in the cultural system, then it should have significant effects on the social subsystem. In fact, Sahlins (1965: 9-10) has proposed that material exchange may have had a more important function socially than technologically.

Patterned variability in chipped stone tool assemblages is the result of resource and environmental constraints such as quality of raw material, its availability, abundance, proximity, and accessibility; with these variables controlled, it becomes possible to examine and interpret aspects of cultural behavior such as methods of raw material procurement, site location preferences, and manufacturing technologies (Reid 1978: 49). This report is an attempt to determine and

control these variables in an effort to discover behavioral patterns associated with the procurement and utilization of chert resources in the Harry S. Truman Reservoir area in southwest Missouri.

In order to conduct an intensive study of chert resource availability, procurement, and utilization at various sites within the Truman Reservoir, the following steps in a research design were formulated and implemented:

1. Review the literature.

2. Study the geology, geomorphology, and geography of the Truman Reservoir area.

3. Conduct a systematic survey and build a collection of chert samples from various chert types and chert sources within prescribed territories.

4. Analyze and classify the geologic chert samples and archeological chert artifacts recovered from area sites.

5. Compare the analyzed geologic and archeologic cherts and interpret the data.

The main objectives of this research design are four-fold; the first three objectives were accomplished in the field during the summer 1979 Chert Survey and the fourth during the following fall and winter: (1) To determine what types of chert resources were available to prehistoric flint knappers in the Truman Reservoir and the quality of these resources, (2) to determine the extent and distribution of the different potential resources, (3) to procure samples from the different chert types and sources to curate for comparative purposes with actual artifacts from selected sites, (4) to determine differential chert utilization patterns at selected sites (by chert identification of archeological artifacts) and to relate these data to those on chert availability.

The first objective pertaining to the availability and quality of chert resources was probably the most important factor to the aboriginal flint knapper for it would control the amount of energy expenditure or social relationships needed to procure raw material for the manufacture of chipped stone tools. Chipped stone or chert artifacts play an important role in subsistence (hunting, gathering, and horticulture), defense, utilitarian, ceremonial, and exchange subsystems. In areas where naturally occurring silicious materials are absent or are of very poor quality, there is the implication for social interaction on a regional scale for the procurement of this necessary resource; such implications can be confirmed by the identification of exotic

cherts manifested in artifactual remains. On the other hand, in areas blessed with quantities of fair or good quality cherts, there is still the implication of regional social interaction — exportation of chert resources — but verification may be more difficult.

In areas like the latter, a study such as this would need to determine as nearly as possible the extent and distribution of the potential chert resources. It is not enough to simply determine the types and quality of chert available in a region; the extent of the chert resources is also important information since large exposures of quality chert-bearing formations would indicate probable major resources, whereas small outcrops would tend to point to minor resources. Likewise, the distribution of chert resources is important if one is dealing with a large study area. It makes a difference whether the chert resources are ubiquitous or are limited to a certain portion of the study area, for example, to just the Southeast. Such knowledge may have been a major factor in settlement location.

The third and fourth objectives of procuring raw chert samples from the entire range of different chert types and sources for comparative purposes with actual artifacts recovered from sites and the subsequent chert identification of the archeological artifacts are very important. Analysis generated by the data should determine which chert type(s) was (were) favored due to quality, abundance, availability, accessibility, proximity to the site, etc., and the percentage of local, non-local, and exotic cherts used.

Two additional objectives for the Chert Survey were: to procure chert from the same resources exploited by prehistoric peoples for flint knapping, use-wear, and heat treatment experiments and also for possible future trace element analysis; and to look for and survey any prehistoric quarries, lithic reduction sites, or other chert-related cultural activities.

It was hoped that the fulfillment of these objectives would reveal chert procurement and utilization patterns established by prehistoric inhabitants of the Truman Reservoir area. The study should shed light on the questions of where and how the flint knappers were procuring their raw material for chipped stone tools, which particular type(s) of chert they preferred the most and why, and possible chert exchange relationships.

Although this chert resource study was conducted to accomplish the immediate objectives cited above, the information derived from it was intended to be integrated and

articulated with various other research interests of the Truman Project: it should provide important data for the analysis of site artifact assemblages and the writing of site reports.

LITERATURE REVIEW

In spite of the importance of lithic resources in reconstructing prehistoric technology and, indeed, prehistoric culture in general, there are relatively few studies and even fewer publications on the availability and/or utilization of chipped stone resources in North America. Some works deal with either the description, availability, or utilization of lithic resources but only a few have integrated these aspects. Many more large scale lithic resource studies need to be conducted in a problem-oriented way in order to examine and determine the various influences and interrelationships that once existed between the lithic technology subsystem and the broader cultural system. Although the number of reports on chipped stone resources to date is not very impressive, an awareness of the importance of such studies is growing as evidenced by publication dates. The following is a chronological literature review of all the various studies dealing with chipped stone resources that I am aware of in the midcontinental United States.

One of the first studies of chipped stone resources was made by Thomas Meyers (1970) whose goal was to determine the location and importance of some of the local raw material sources in the lower Illinois River Valley. His field research was restricted to sampling chert in the vertical limestone bluffs along the Illinois River Valley. Although he mentions two other major potential chert sources (residual and redeposited chert), no attempt was made to sample these alternative sources. He does note, however, that "in terms of the quantity of chert available and ease of procurement, these stream-bed gravels were probably the most important chert source in the lower Illinois Valley region" (1970: 34). Thus, with the exception of the data from the bluffs, this report on the chert resources in the lower Illinois Valley region is both tentative and subjective. In addition, there was no comparative analysis of the chert samples collected from the bluffs to chert-artifacts collected from sites to determine chert utilization.

Appendix I of Walter E. Klippel's dissertation (1971) is a small study of the chert resources within a three mile radius of Graham Cave in east-central Missouri. Some samples of the two major chert-bearing formations (Jefferson City and Burlington) in the area were collected and described according to color, presence/absence of fossils, and luster.

Lawrence L. Loendorf (1973), in a study of prehistoric settlement patterns in the Pryor Mountains of south-central Montana, suggested that natural resources were exploited in a seasonal transhumance cycle through five delimited environmental zones, each zone containing particular types of lithic resources. As a test for his suggested seasonal settlement pattern, the relative amounts of seven kinds of chipped stone debitage found on certain occupation sites were used; these, he states, were dependent upon the location of a site when compared to the locations of different quarries. In other words, the element of change in the test was the distance from a quarry to a site. He concluded that since the relative amounts of chipped stone debitage change as people move away from a quarry, he was able to determine the direction of movement in the mountains, and that principally the test supported his proposed seasonal settlement cycle.

John H. House (1975) reported on the utilization of lithic resources spatially and temporally as manifested in artifact collections but very generally stated the distribution and availability of chert in the Cache Basin and surrounding region in northeast Arkansas. He did not conduct a sampling program to determine quantity, quality, and exact location of chert sources. House postulates modes of transportation of the two main types of chert utilized, but the distribution of the cherts at sites in the basin was not quantified (Schiffer and House 1977: 50-51).

Barbara E. Luedtke (1976) studied exchange and interaction patterns during the Late Woodland period in the Upper Great Lakes area of Michigan by using lithic material frequencies as an index. Luedtke used trace element analysis through neutron activation to characterize and identify chert samples and artifacts. Her conclusions were: that chert exchange occurred primarily as an accompaniment with other exchange goods rather than an end in itself; that chert was more likely to be traded as artifacts than as raw material; and that exchange networks tended to correspond to natural means of transportation, such as along rivers and lakes.

Stanley A. Ahler (1977) tested Lehmer's hypothesis (1954: 131) that in north-central South Dakota people of the Middle Missouri Tradition obtained non-local Knife River Flint as a major lithic resource via trade, while people of the later Coalescent Tradition relied more heavily on locally available raw materials. Ahler first defined twelve different types of chipped stone raw materials based on geological information and limited field surveys of major resource locations. Seven of these raw materials are referred to as "non-local," occurring as far away as the adjacent states of North Dakota, Wyoming and Nebraska. The

five remaining types are called "local" materials which occur in three kinds of secondary deposits (glacial till, glacial outwash terraces, and alluvial terraces). Ahler then compared excavated artifact assemblages from four sites (two of each tradition) to quantify and determine lithic resource utilization patterns. His analysis of the data supports Lehmer's hypothesis of differential selection of lithic resources. In addition, analysis of data on flaking debris and tools produced "a certain amount of correlation between the technological operations performed at a site, the quality of the stone occurring in the artifacts, and the distance to the source of the raw material" (Ahler 1977: 145).

In a report on the Nebo Hill site in western Missouri, Kenneth C. Reid (1978) dealt with the availability and utilization of chert by delimiting a study area 8 km in diameter around the site. He first related the site to the availability of surrounding chert resources (specifically one major quarry site) and then analyzed excavated bifaces, cores, and flake tools as to chert type. In this report and a later article (Reid 1980), Reid summarizes descriptive and distributional data on four previously undescribed Upper Pennsylvanian cherts of the Missourian Stage (Kansas City and Lansing Groups) which are located mostly in northeastern Kansas and northwestern Missouri. Reid analyzes each chert type in terms of its identity and internal variability of various physical properties, geological context, source areas, procurement techniques, flaking properties, responses to heat treatment, and geographic distribution.

Marvin Kay, et al. (1978), working at Rodgers Shelter in the eastern portion of the Truman Reservoir, recognized the local Jefferson City, Chouteau, and Burlington cherts and the three types of sources in which they occur; they also classified cores, chert hammerstones, and bifaces according to chert type.

Cherie E. Haury (1979a) delimits and describes the variety of chert types available within the El Dorado Lake area in south-central Kansas. In an unpublished paper (1979b), Haury discusses the accessibility, relative abundance, and knapping quality of four types of chert sources (bedrock exposures, alluvial deposits, residuum, and high terrace gravels) in which some of these chert types occur. Although Haury does not deal with utilization of the chert resources, Gary Leaf (1979) does divide artifacts from five test excavations at El Dorado Lake into chert types.

Julie E. Francis (1980) discusses several concepts and hypotheses which propose that different patterns of lithic raw material procurement and utilization can be shown to indicate changes in hunter-gatherer subsistence and settlement

systems. First, she mentions procurement strategies of raw materials (direct and indirect) and implications as to how these particular strategies might be recognized and then discusses several hypotheses pertaining to changes in subsistence and settlement systems from Paleo-Indian to Archaic time periods. Her basic argument is that changes in certain aspects of these hunter-gatherer systems should be associated with and reflected in the procurement and utilization of lithic resources. An unpublished paper by Francis (1979) physically describes various chipped stone raw material resources in the Bighorn Mountains of north-central Wyoming but does not quantitatively deal with chert utilization.

Judy K. Michaelsen (1980) explores lithic procurement economizing behavior via analysis of chipped stone assemblages from the Red Desert of south-central Wyoming. Michaelsen hypothesizes that as the distance between sites and a lithic resource increases, there will be a corresponding decrease in the utilization of that resource and thus a decrease in the number of cores, dorsal cortex flakes, and size of debitage manufactured from that particular lithic resource. She used a single unnamed oolitic chert source in her utilization analysis. Michaelsen's data generally supports the lithic procurement economizing hypothesis and its applicability to the Red Desert of Wyoming.

Although these pioneering reports are important and have an essential place in the literature, most are general or preliminary (descriptive) reports. Only a few of these reports can be considered in-depth, problem-oriented studies of both the availability and utilization of chipped stone resources. As the publication dates clearly indicate, there is a growing awareness of the need for special studies of lithic resources; over three-fourths of these reports have been conducted over the past six years. Still, many more chipped stone resource studies need to be made throughout North America and it is hoped that this decade will witness a surge in this direction.

The present chert resource study is an integrated treatment of chert resource availability, procurement, and utilization in the Truman Reservoir area of southwest Missouri with a problem-oriented design to determine various utilization patterns of the available chert resources. This study included conducting intensive geological field surveys of chert types and sources for collecting data on the availability of chipped stone resources and subsequent laboratory identification, classification, and analysis of chert types in artifactual assemblages in order to quantify utilization patterns.

GEOLOGICAL SETTING

The study area is located on a geomorphic and geologic ecotone separating three major physiographic provinces (Fig. 1) in southwest Missouri: the dissected Ozark (Salem) Plateau to the south and east, the unglaciated prairie region (Cherokee Lowland) to the north and west, and the Springfield Plateau situated in between (Fenneman 1938; McMillan 1976: 13; Ward, et al. 1977: 2). The boundary between the Salem and Springfield Plateaus is often delineated at the Eureka Springs Escarpment, the regional contact of the Ordovician and Mississippian aged strata (Bretz 1965: 30-31). The underlying bedrock formations become progressively younger as one moves west across southwest Missouri – the older, uplifted Ordovician rocks exposed in the Ozarks becoming buried by Mississippian limestones on the plains (McMillan 1976: 14).

Although there are six types of chert-bearing dolomite and limestone formations within a 50 km radius of the center of the Truman Reservoir, only the Jefferson City, Chouteau, and Burlington formations outcrop directly within the reservoir (Fig. 2). After a discussion of each formation and a general description of the inclusive chert, a detailed physical description of each chert type will follow. A descriptive summary of all six chert types occurring within or adjacent to the Truman Reservoir is presented in Table 1.

A set of conventional abbreviations, following the geologic symbols used to represent formation names on the Geologic Map of Missouri (Anderson, et al. 1979), are used in this report. The symbols are usually straightforward, for example: Ojc represents the Ordovician-aged Jefferson City formation; Og stands for the Ordovician Gasconade formation; Or denotes the Ordovician Roubidoux formation; and Pkc represents the Pennsylvanian-aged Kansas City Group of formations. A few symbols, however, are less straightforward: Mk represents the Mississippian-aged Kinderhookian Series of formations used here to identify the undifferentiated Chouteau formation, and Mo represents Mississippian Osagean Series of formations used here to designate the undifferentiated Burlington formation. In each case, the formation symbols are extended to denote the respective inclusive chert types.

The oldest of the three chert-bearing formations is the Ordovician Jefferson City (Ojc) dolomite (a high magnesium, low calcium carbonate limestone) which is predominantly found east of the Eureka Springs Escarpment located just to the west of the Pomme de Terre River (Fig. 1, 2). However, this formation is also found west of the Eureka Springs Escarpment in the deeper cut major stream valleys and in

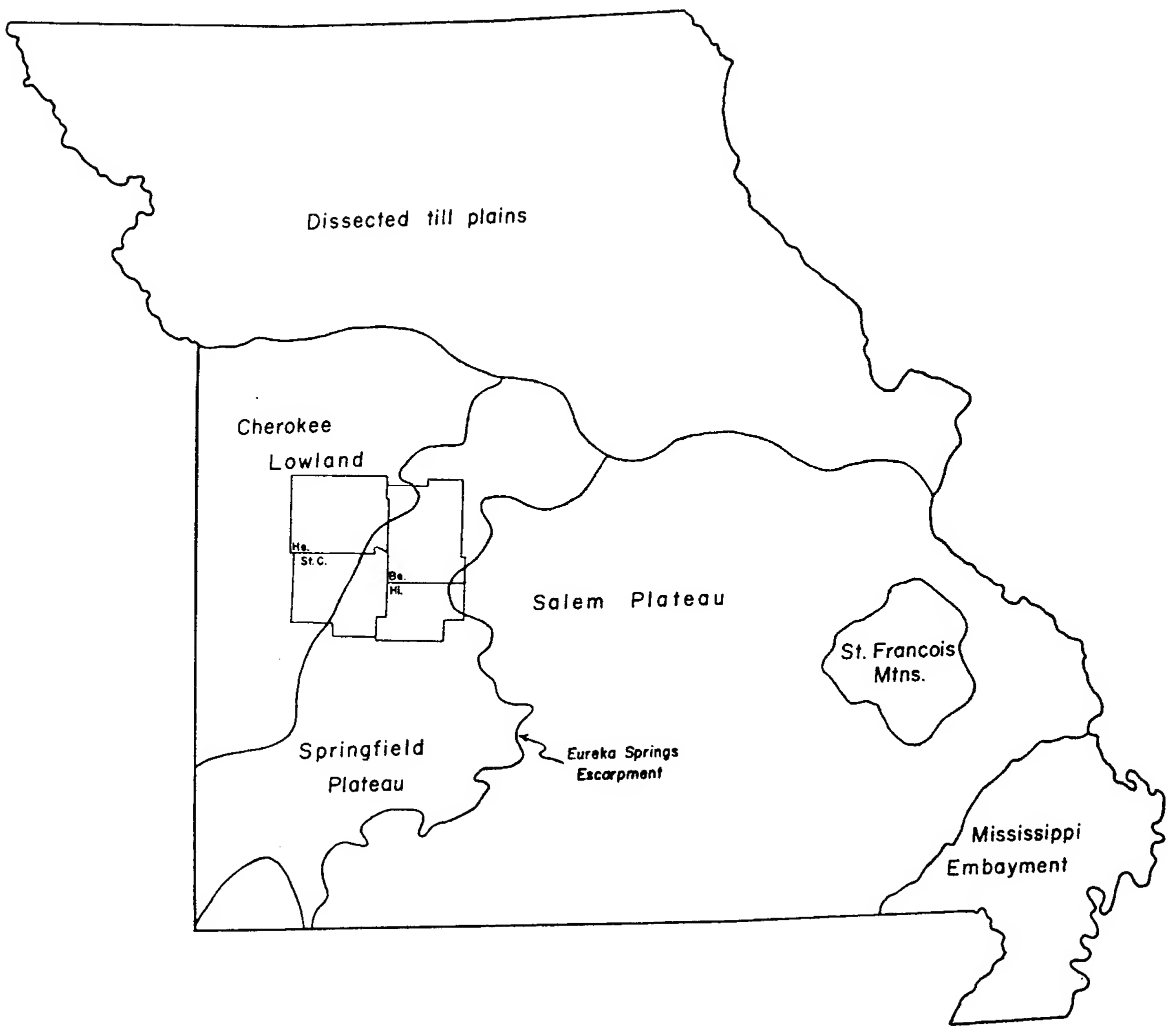

Figure 1. Truman Reservoir in relation to physiographic provinces (after Fenneman 1938).

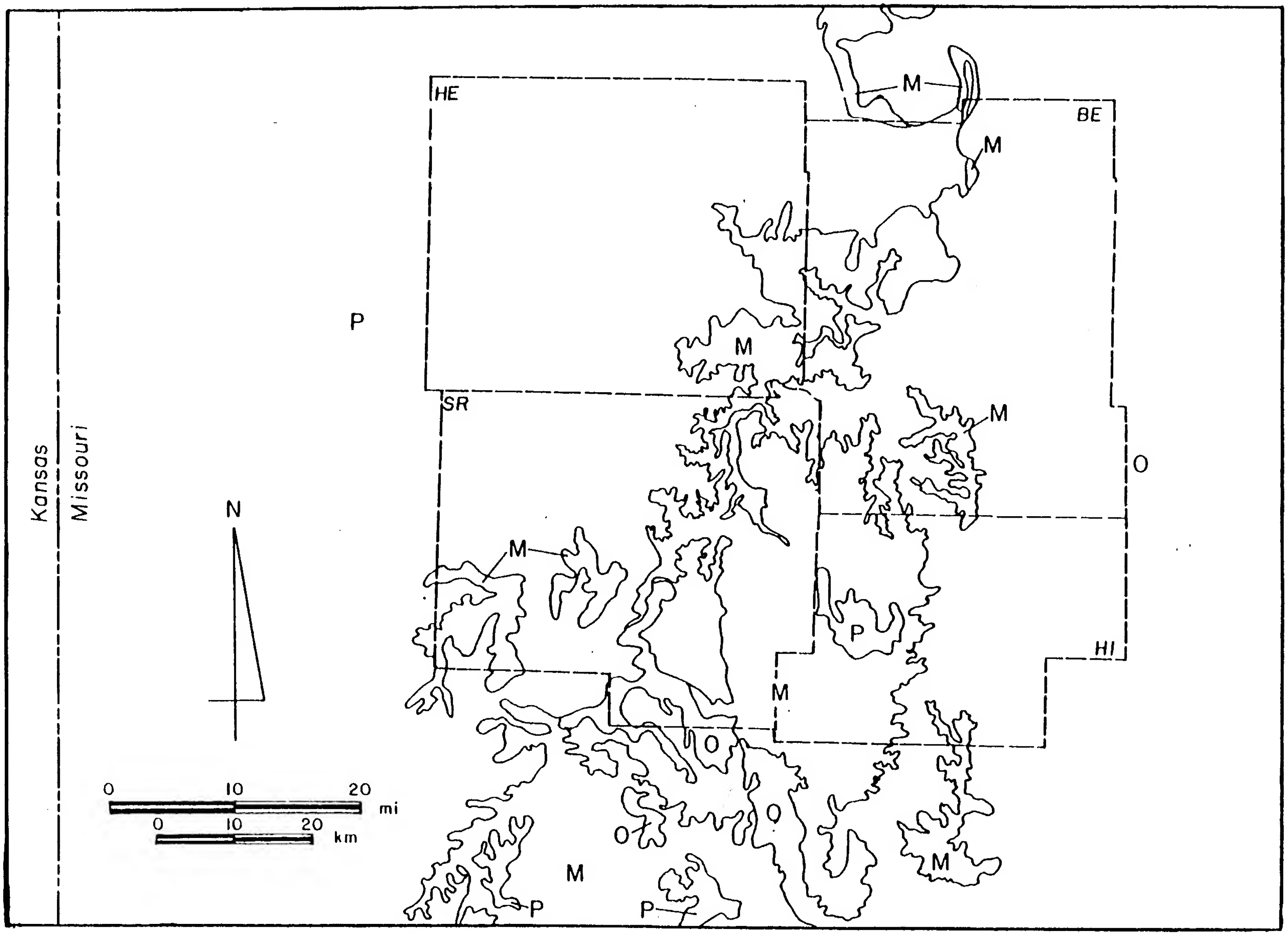

Figure 2. Geologic map of formation outcrops in the Truman Reservoir area (after Anderson, <u>et al</u>. 1979).

locally up-arched or faulted areas. The Ojc formation (Fig. 3) is used here in an unrestricted sense to include the often distinguished but very similar upper Cotter dolomite section. The Cotter is generally insignificant in the reservoir area and is totally absent in St. Clair County where Mississippian strata lie unconformably on the Ojc formation (Knight and Hayes 1961: 24). Lithologically, the Ojc is either a light brown to brown, fine-grained argillaceous dolomite ("cotton rock") or medium to fine-grained crystalline dolomite (Knight and Hayes 1961: 23). The Ojc chert is characterized as commonly occurring in ellipsoidal nodules which often exhibit concentric banding in cross section. The color varies from light to dark blue and brown and white. Fossils are scarce in this fine-grained chert, although much of it is oolitic (Beveridge 1951: 24).

The Chouteau (Mk) and Burlington (Mo) formations compose the overlying highly fossiliferous Mississippian system, separated from the older Ordovician system by an unconformity, an ancient erosional surface (Plate 1a). The lower part of this Mississippian system is combined into a unit called the Chouteau Group which actually comprises three formations – two limestones and one shale. However, the nomenclature is confusing on this subject because many names have been used interchangeably to designate the stratigraphic sequence (Beveridge 1951: 30; Ward, et al. 1977: 9; Allen, et al. 1975: 18) and because the chert from the formations is identical in appearance (Beveridge 1951: 32), making it extremely difficult to differentiate between them in the field. The term Chouteau will, therefore, be used here in an unrestricted sense to refer to any chert obtained from the lower portion of the Mississippian system (Fig. 3). The Mk limestone outcrops throughout the reservoir, sandwiched between the Ojc and Mo formations (Plate 1a). Lithologically, the Mk is a grey to light brown fine-grained, finely crinoidal limestone, which is locally silty or argillaceous (Spreng 1961: 56-57). The Mk chert is characterized by its light and dark mottled grey core and a prominent white outer cortex.

The highly fossiliferous Mo limestone (Fig. 3) constitutes the upper part of the Mississippian complex and is easily distinguishable from the former lower section because a stratum of Northview shale (Mn) one-half to one meter thick separates the two chert-bearing limestone formations (Plate 1a). Lithologically, the Mo is uniformly a massively bedded white to light grey very coarse-grained, highly and coarsely crinoidal limestone (Spreng 1961: 64). The Mo limestone produces a better grade of white to light buff and grey chert characterized by diagnostic crinoid fossils that are usually very abundant.

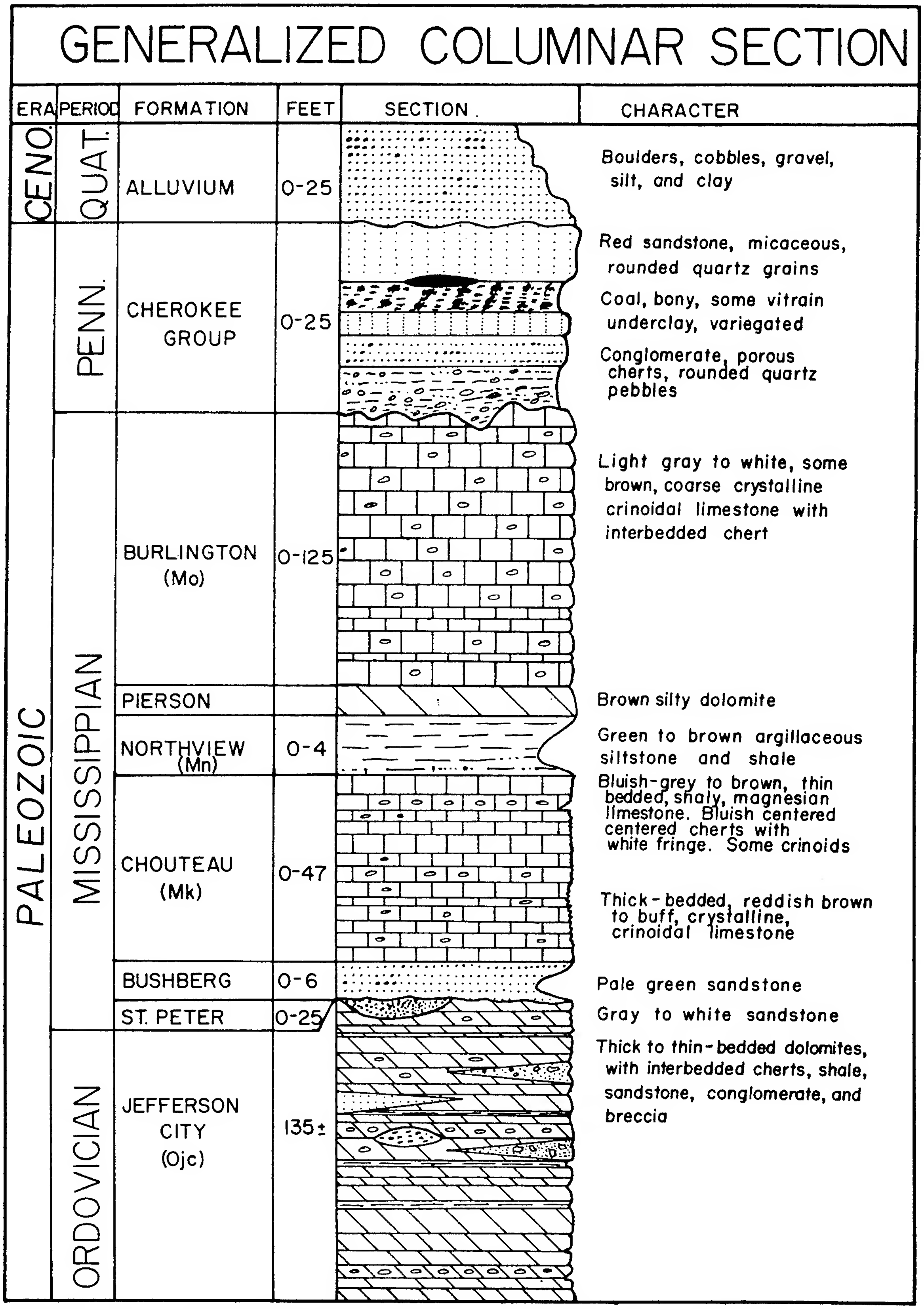

Figure 3. Generalized columnar section of Jefferson City, Chouteau, and Burlington chert-bearing formations which outcrop within Truman Reservoir (after McMillen 1950).

The Mo formation is also used in an unrestricted sense to include the sometimes distinguished lower Pierson formation and upper Keokuk limestone. There has been much controversy over the Pierson formation in south and west-central Missouri (Beveridge 1951: 46; McMillen 1950: 50-60; Spreng 1961: 60) for two reasons: (1) this dolomitic-limestone "formation," which lies directly above the Northview shale formation, thins rapidly from the deeply stratified type area in extreme southwestern Missouri to less than 3-4 meters in the west-central part of the state and the Truman Reservoir area (Plate 1b), where it is often regarded as the lower brown dolomite bed of the Mo limestone (Spreng 1961: 60); (2) it is lithologically similar to the upper Mk limestone. However, most studies in the Truman Reservoir area tend to include the Pierson in the Burlington formation and distinguish it as basal Burlington (Beveridge 1951: 46-47; McMillen 1950: 60). Unfortunately, the chert of this basal Burlington is often very similar in appearance to Mk chert and it is sometimes difficult to distinguish between them. Still, the basal Burlington chert can usually be distinguished from Mk chert by its purplish tint, more and slightly larger crinoids, and its coarser-grained texture. In addition, the thinness of the basal Burlington, the scarcity of chert in this section, and the chert's over-all poor quality tend to make it a poor chert for flint knapping purposes. Because the boundary between the Mo formation and the sometimes differentiated overlying Keokuk limestone is obscure and since the limestones and cherts are nearly identical, the two are combined into one unit in most reports (Spreng 1961: 64).

The Nature and Genesis of Chert

Before presenting the detailed descriptions of the inclusive cherts of the above formations, a short discussion of the nature and genesis of chert is appropriate.

Chert or flint is a dense, microcrystalline (or cryptocrystalline) quartz consisting of between 97 and 99% silica (SiO_2) and three to one per cent water and other mineral impurities; the silica is chalcedonic or fibrous in nature (Frondel 1962: 219-21). The formation of chert and flint is still not clearly understood. It is presently thought to be either a silica precipitate deposited in shallow seas (Tarr 1926: 24) or in limestone via ground water (Hamblin and Howard 1975: 47), or a silica replacement of limestone or dolomite during the diagenesis of the rock (Frondel 1962: 222).

The distinction between flint and chert has never been clear-cut; some authors use the terms synonymously while others differentiate between the two on the basis of color (Tarr 1926: 2-5), consistency, location, or formation

process. Still, a consensus of the literature tends to define flint as a homogeneous, fine-grained, and dark-colored variety of chalcedony, whereas chert is said to be a coarser-grained, lighter-colored variety containing more impurities (Hamblin and Howard 1975: 13; Frondel 1962: 221; Semenov 1964: 34). Since the specimens dealt with in this study generally exhibit the latter characteristics cited above and for the sake of consistency, the term chert will be used in this report to refer to any variety of chalcedony studied in the Truman Reservoir.

Truman Reservoir Cherts

JEFFERSON CITY CHERT (Ojc)

Jefferson City (Ojc) chert occurs in lenticular beds, as "free" nodules (Plate 2a), and sometimes in thin bands 3-5 cm thick (Plate 2b) within the dolomitic matrix. The nodular chert may be ellipsoidal, round, or irregular. Quartzose (hard sandy chert) is commonly associated with Ojc chert; it occurs in nodules and occasionally as inclusions within a chert matrix. Although not as common as in older Ordovician cherts, an additional trait besides quartzose patches, which sometimes reduces the knapping quality of Ojc, is the occasional presence of pockets of druse (quartz crystals) and various small inclusions.

Subjectively, from an amateur flint knapper's point of view, Ojc chert is generally the best quality chert in the Truman Reservoir area. It is usually very distinctive, although some white and light grey varieties might be confused with younger Mississippian cherts. Typical good quality Ojc is smooth and has a fine-grained, glass-like texture; thin flakes are usually translucent. Jefferson City is the most variable chert in color but is usually light to dark: blue, brown, grey, purple, pink, or white.

Jefferson City chert most often occurs in three varieties: oolitic, banded, and mottled. Oolitic Ojc is a common variety (Plate 2c). The oolites, small spherical grains, are generally relatively small compared to other Ordovician cherts with individual oolites averaging 0.5 mm to 0.75 mm in diameter (Beveridge 1951: 24); they may be sand-centered, concentrically banded, or unstructured. The oolites may be the same or different color than the matrix, densely or widely dispersed, and some may be elongated or disk-shaped. Oolites are the most diagnostic trait of Ojc chert since they do not occur in Chouteau and Burlington cherts.

Banded Ojc chert (Plate 2d) is common to ellipsoidal nodules and is often concentric in cross-section; the bands

are usually white alternating with blue, brown, grey, black, or purple. Banding is relatively diagnostic of Ojc since Mississippian cherts are rarely banded.

Mottled Ojc chert (Plate 2e) is more common to irregular nodules; the mottling may be a combination of any of the dominant colors. The mottled Ojc chert is slightly different from mottled Mississippian cherts in that it usually exhibits a streaked and swirled pattern or disturbed banded appearance. Although mottled Ojc is the least diagnostic variety, this feature, in combination with the characteristic smooth, fine-grained, glass-like texture and the absence of fossils, is a fairly reliable indicator.

Fossils are very scarce in Ojc chert. The only definite fossils identified in Ojc chert by the 1979 Chert Survey were gastropods at one site (HI Ojc 7) in Hickory County NW1/4 SE1/4 NE1/4 Sec. 9, T. 37 N., R. 22 W. Beveridge (1951: 27), in a study of the geology of the Weaubleau Creek area, also noted that fossils were scarce and that gastropods were the only forms he found in the Ojc formation. Fossils common to the Mississippian cherts (crinoids, bryozoa, and brachiopods) are totally absent in Jefferson City chert. Siliceous spicules or "spines" (possible or uncertain fossils) may be found occasionally in the chert.

The above characteristics, either singly or in combination, make Ojc chert rather easy to identify. As Beveridge (1951: 24) has pointed out:

> The cherts of the Jefferson City are invaluable in field mapping, for they form much of the float of this poorly exposed formation and can be megascopically distinguished from cherts of younger formations.

CHOUTEAU CHERT (Mk)

Chouteau (Mk) chert usually occurs in a lenticular, sub-rectangular, or tabular nodule (Plate 3a) having a prominent thick white cortex. The core consists of a mottling of light and dark blues and greys (Plate 3c); the resultant mottled bluish-grey, bluish-black, and grey colors are usually emphasized by a very waxy luster or sheen. The Mk chert is fairly fossiliferous containing predominantly crinoids, bryozoa, and brachiopods in that order. Spines at times are also abundant. The best diagnostic fossiliferous trait of Mk is the uniformly small size of the individual crinoids which usually average only 2 to 3 mm in diameter (Beveridge 1951: 31). The mottling in Mk is not the same as in Ojc chert. Whereas, mottled Ojc exhibits a swirled or streaked appearance, Mk's mottling is in the form of irregular blotches or spots — a good diagnostic physical trait.

The texture of Mk chert ranges from fine to coarse-grained. The chert is almost always opaque.

Surprisingly, a large portion (usually 85 to 90%) of the Mk chert has a blocky structure with many incipient fracture planes along which extensive weathering has occurred. Because of this, it is usually brittle and breaks very easily along these weathered fracture planes, causing the vast majority of Mk to be poor quality chert unsuitable for flint knapping purposes (Plate 3b). The best quality Mk chert found during the 1979 Chert Survey was a fine-grained bluish-black unmottled variety with a highly vitreous luster; it was also full of small crinoids, bryozoa, and spines.

BURLINGTON CHERT (Mo)

The highly fossiliferous Burlington (Mo) chert (Plate 3d) is basically white, tan, buff, or light grey in color. Some mottling does occur but it is common only in basal Mo chert. Banding is very rare although it was observed at a couple of sites during the 1979 Chert Survey. The chert ranges from fine to coarse-grained and is generally opaque; it may sometimes exhibit a speckled appearance.

Probably the most diagnostic trait of Mo chert is its abundant and large crinoid fossils, which contrast sharply with the smaller more simple crinoids of Chouteau. These Mo fossils are often twice as large as Mk crinoids (commonly 5 mm in diameter) and much more prevalent. Another characteristic of Mo crinoid fossils is that they frequently occur as portions of intact columnal stems, whereas in Mk chert the columnal segments have been separated into single disks. Other fossils commonly found in Mo chert are brachiopods, bryozoa, and spines.

Highly weathered Mk and Mo cherts superficially resemble one another. However, these two cherts may be distinguished not only by the contrast of their fauna, but also by the relationship of the fossils to the matrix (Beveridge 1951: 35). Chouteau fossils, replaced by silica, are so fused with the matrix that they cannot be separated from it and thus fractures usually extend through the fossils. Burlington fossils, on the other hand, are not always completely replaced and filled by silica and therefore fractures often extend around the fossils rather than through them — this is especially true near the cortex.

Burlington chert occurs in the form of continuous layers (Plate 4a) or more commonly in irregular nodules, often quite large (Plate 4b). Intense weathering produces dull tripolitic Mo, which if highly fossiliferous, is especially porous (Beveridge 1951: 46).

Cherts Surrounding Truman Reservoir

Three additional chert-bearing limestone formations surround the Truman Reservoir but do not outcrop directly within the reservoir boundaries. Sample expeditions were made to these potential sources for identification and comparative purposes but intensive surveys were not conducted in these areas. Therefore, descriptions are not as comprehensive as those for the three previous cherts that outcrop within the reservoir, which were extensively sampled during the Chert Survey of 1979.

ORDOVICIAN CHERTS

The Gasconade and Roubidoux formations (Fig. 4) and cherts located to the east of the reservoir present an interesting problem. Since all the streams cutting into these Ordovician strata in central Missouri drain northward directly into the Osage River below the Truman Dam (Fig. 2), none of their cherts would be expected to be found naturally in the Truman Reservoir vicinity. Thus, any Gasconade or Roubidoux cherts identified in artifact collections from the reservoir would have to have been carried west via trade, seasonal movements, or procurement expeditions.

Although the limited chert gathered from these two formations was found to be vuggy (full of openings or crevices), drusy, poor quality material, better quality chert may be found further east in the Ozarks as evidenced by a sample from the Gasconade River Valley in Maries County.

According to the Geologic Map of Missouri (Anderson, et al. 1979), the nearest source of Gasconade (Og) chert is located 15 km from the easternmost edge of the Truman Reservoir and 30 km from the center of the reservoir. Based on a limited sample of Og chert gathered from the valleys of Deer and Starks creeks in Benton and Hickory counties, Og, the oldest Ordovician chert in the state, is blue, grey, and white banded, sometimes contains elongated, irregular, bean-shaped oolites, and is very vuggy and drusy, making for a poor quality chert. Gasconade oolites are generally opaque, are not sand-centered, and have no rinds or sharp interfaces (Groves 1979: personal communication). Fossils are usually rare except for mollusks which are commonly present in the chert (Knight and Hayes 1961: 22). Marbut (1907: 27-30) in a study of the geology of Morgan County, to the east of the reservoir, says that Og chert usually occurs in beds and is rarely oolitic. Although several varieties of chert characterize different parts of the formation, he says the most common form in which it occurs is very porous coral-like masses. In a report on the geology of Miller County, Ball and Smith (1903: 34-35) characterize Gasconade chert as occurring in either bedded or in irregular

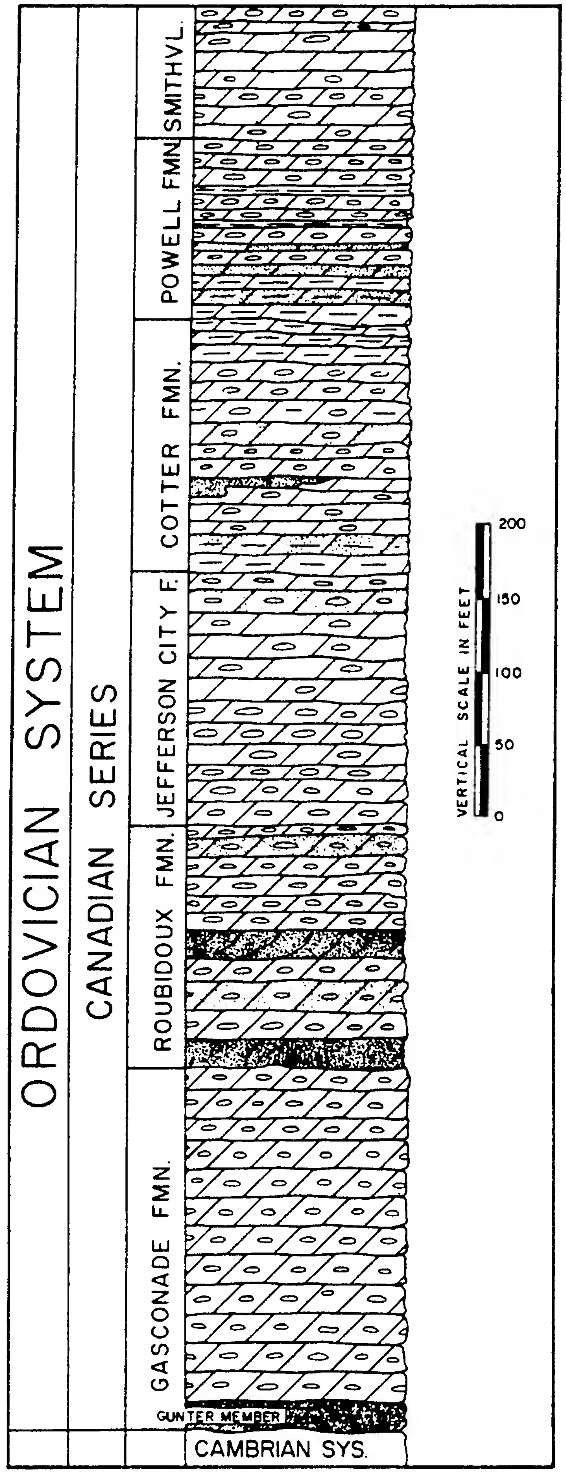

Figure 4. Geologic column of Gasconade and Roubidoux formations (after Koenig, ed. 1961).

pieces, masses, or nodules, as very grainy and almost amorphous, and as commonly containing drusy cavities lined with small quartz crystals. Most sources agree that Og chert is most abundant in the lower portion of the formation in contrast to the much smaller amounts in the upper portion (Marbut 1907: 28; Knight and Hayes 1961: 22; Heller 1954: 13). The scarcity of chert in the top part of the Og formation would tend to suggest that sizeable quantities of Og chert would be found only further east in Camden County and the Lake of the Ozarks area where the formation is deeply cut and well exposed.

Roubidoux (Or) chert is found 5 km closer to the Truman Reservoir in the stream valley of Turkey Creek. Samples of this Ordovician chert were also collected from Deer Creek and Little Niangua River valleys further east. From these areas, samples of Or chert were banded grey and white, very vuggy and drusy, sandy, and oolitic; quartzose was common in the chert nodules. Although normally sparingly fossiliferous, a few gastropods were identified. In general, Or chert is much sandier, oolitic, and lighter in color than Og chert. Roubidoux oolites are usually relatively large (.6-.8 mm), are sand-centered, and have well-defined rinds; a distinct trait is a radial pattern sometimes developed in the oolites (Groves 1979: personal communication). Ball and Smith (1903: 56) and Marbut (1907: 33) state that heavily bedded, rugged brecciated chert, which is the most uniform and characteristic, occurs at the base of the Or formation, whereas, cellular or honeycombed chert occurs in the upper part of the formation. Heller (1954: 21) claims that although the Or chert is highly variable in character ranging from porcelaneous, banded varieties to arenaceous and oolitic types, the sandy and oolitic cherts are most characteristic of the formation, though they are not always the most abundant. He says the Or chert occurs in irregular beds of variable thickness and in irregular nodules and lenses within the dolomite. Heller (1954: 22) says Or chert differs from Og chert in three respects: it occurs in relatively larger amounts, it is much sandier, and it is generally lighter in color.

It should be noted here that although fairly specific oolitic traits have been mentioned as characteristic of a certain Ordovician chert, none are mutually exclusive or definitely diagnostic to a particular type. Traits mentioned here as characteristic of oolitic Og or Or have been identified in Ojc oolitic samples. The three Ordovician cherts resemble each other in overall physical appearance; what usually separates Ojc from Og and Or is its superior quality (finer-grained) with generally lesser amounts of inclusive druse, quartzose, and especially vugs.

In conclusion, since these two early Ordovician cherts tend to be generally rugged (vuggy, drusy, sandy-grainy) and

because of the distance factor, they are not thought to have been important chert resources for the prehistoric inhabitants of the Truman Reservoir area.

MISSISSIPPIAN CHERT

The Warsaw formation (Fig. 5) and its fossiliferous chert located southwest of the reservoir (Fig. 2) presents a different problem than the Ordovician cherts. Although this Mississippian formation outcrops twice as far from the center of the reservoir as the Og and Or formations, tributaries of the Sac and Osage rivers traverse the Warsaw strata supplying an available source of stream bed chert to the reservoir area. However, the long distance this chert would have to be transported by stream action should cause the quality to be questionable. Sites suspected of having any stream bed Warsaw chert should be only those along the Sac and Osage rivers.

According to the 1979 Geologic Map of Missouri (Anderson, et al. 1979), the closest source of Warsaw (Mm) chert is located 20 km southwest of the extreme upper end of the reservoir on the Sac and Osage Rivers, but 50 and 55 km from the center of the reservoir. The one Mm site sampled in Cedar County revealed nodules with a bluish-grey matrix and many small dark fossils; some of the chert also exhibited some mottling and weak banding. The majority of the fossils present were very small crinoid fragments, along with bryozoa, spines, and fusilenids. Groves (1979: personal communication) notes that normally bryozoa are the dominant fossils, brachiopods are common, crinoids are fewer and smaller than in Mo chert, and that the chert can be pinkish and speckled.

Table 1 is a descriptive summary of all six chert types occurring within or adjacent to the Truman Reservoir. All chert attributes, typical features, or identifying traits are listed (ranked) from the most common or most reliable to least common or reliable. All chert colors would have been coded according to the Munsell Book of Color had there been access to one; however, only the Munsell Soil Color Charts were available. These do not contain such colors as blues and purples present in several of the Truman cherts. Therefore, to be consistent, a more subjective color determination was made outdoors under natural light.

PENNSYLVANIAN FORMATIONS

Several Pennsylvanian formations outcrop between the western edge of the reservoir and the Missouri-Kansas state line (Fig. 2); a few outliers also exist in eastern St. Clair and western Hickory counties. Chert is reportedly very rare in these formations, which are composed mostly

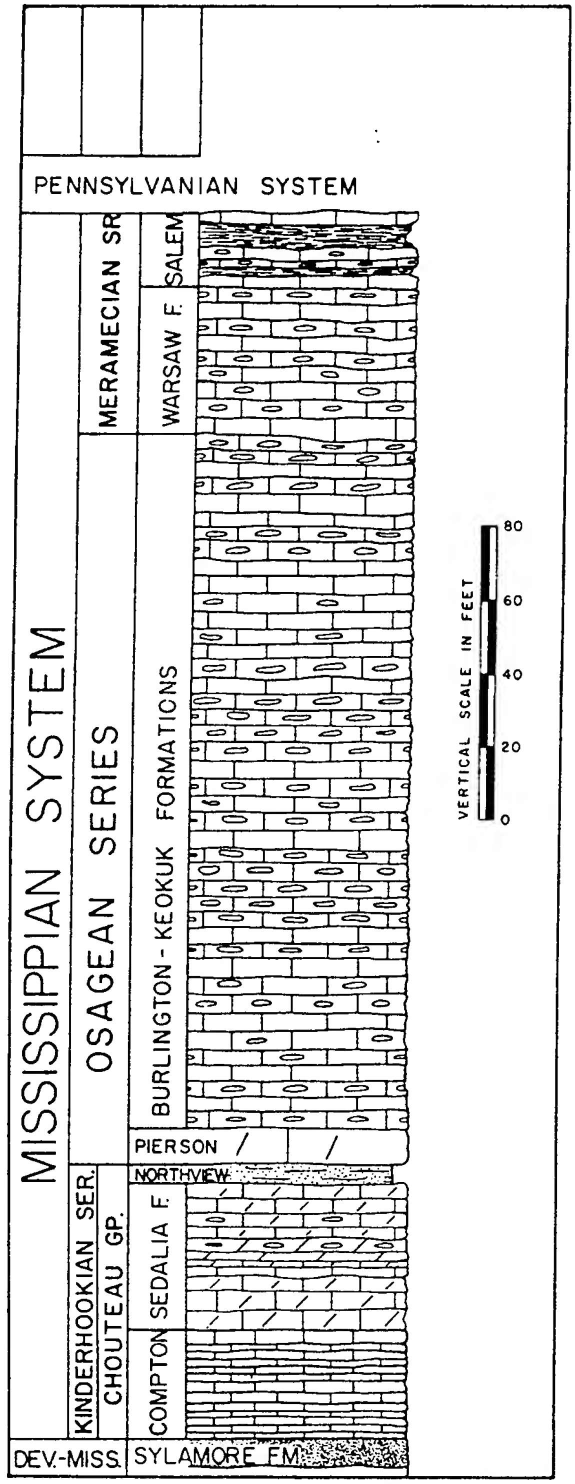

Figure 5. Geologic column of the Mississippian System (Warsaw formation (after Koenig, ed. 1961).

TABLE 1

Descriptive Summary of Chert Types

Identification Attributes	CHERT TYPES Gasconade (Og)	Roubidoux (Or)	Jefferson City (Ojc)	Chouteau (Mk)	Burlington (Mo)	Warsaw (Mm)
Morphology	Nodular: porous, coral-like masses or "cabbage heads"; Seams	Nodular: "cabbage heads"; Seams	Nodular: ellipsoidal, round, irregular; Lenses; Seams	Tabular, with a thick white cortex; Blocky structure	Nodular: irregular; Seams	Nodular: irregular
Texture	Grainy	Grainy (sandy)	Fine-grained; Glass-like; Smooth	Fine to coarse-grained	Fine to coarse-grained	Fine to coarse-grained
Color	Blue, grey, and white	Grey and white	Highly variable but usually light to dark: blue, brown, grey, purple, pink, white; Translucent	Mottling of light and dark: blues and greys; Often exhibits waxy luster or sheen; Opaque	White, tan, buff, light grey; Generally opaque	Blue, grey, white, pink; Generally opaque
Internal structure	Banded; Oolites: usually not sand-centered and no rinds or sharp interfaces	Banded; Sandy; Oolitic: usually large, sand-centered and well-defined rinds; Brecciated	Oolitic; Banded; Mottled: swirled pattern	Mottled: irregular blotches or spots	Relatively homogeneous; Some mottling; Rarely banded; May exhibit a speckled appearance	Some mottling and weak banding; Can be speckled
Fossils	Usually rare but some mollusks	Usually rare but some gastropods	Very scarce: rarely gastropods and spines	Fossiliferous: crinoids, bryozoa, brachiopods, spines	Highly fossiliferous: crinoids, brachiopods, bryozoa, spines	Fossiliferous: small crinoids, bryozoa, spines, brachiopods, fusilenids
Inclusions	Usually rugged chert: moderate vugs, druse, quartzose	Usually rugged chert: moderate vugs, druse, sand, quartzose	Quartzose; Occasional druse and vugs	Often many incipient fracture planes	Occasional quartzose and druse	
Diagnostic traits		Sandy chert	Oolites; Non-fossiliferous; Banding; Mottling	Irregular blotching or spotted mottling; Small individual crinoids	Abundant and large crinoids; Light colored chert	
Comments	Available samples were poor quality chert	Generally much sandier and lighter colored than Og chert; Poor quality	Generally the best quality chert in the reservoir	High percentage exhibits blocky structure with many incipient fracture planes, therefore, generally poor quality	Fractures sometimes extend around fossils rather than through them; Generally fair to poor quality	Available samples exhibited numerous small bluish fossils

of shale, sandstone, coal, and chertless limestone (Groves 1979: personal communication). To verify this for the Pennsylvanian strata closest to the Truman Reservoir, a survey expedition was made to these formations. All of the streams checked for possible chert deposits were in Bates County.

The first Pennsylvanian strata checked was the Krebs Subgroup (Pck) of the Cherokee Group. This subgroup contains principally sandstone, siltstone, shale, limestone, and coal beds (Searight 1961: 80-81). Panther Creek's stream deposits were examined. Most of the deposits were sandstone but there were also some iron ore nodules and some small, highly weathered chert cobbles, which were unidentifiable because of the highly weathered condition. None of the chert cobbles found at this site were knappable because of the very poor quality and small size (usually 3 cm in diameter).

The next Pennsylvanian strata to be examined was the Cabaniss Subgroup (Pcc) of the Cherokee Group. This strata also consist of sandstone, siltstone, shale, limestone, and coal beds (Searight 1961: 84). A greater quantity of small chert cobbles occurred in Mound Branch than in Panther Creek. The chert cobbles found in this branch were also highly weathered and small - none were knappable. Although this branch is on Pcc strata, Mound Branch's watershed upstream also traverses strata belonging to the Marmaton (Pm) and Pleasanton (Pp and Ppwm) Groups. The Pleasanton Group consists mostly of shales and sandstones (Howe 1961: 96).

The last Pennsylvanian strata examined was the Marmaton Group (Pm) which contains a succession of shale, limestone, and coal beds; the limestone units are more numerous, thicker, and more persistent than in the lower Cabaniss Subgroup (Searight 1961: 90). In New Home Creek the chert cobbles were again highly weathered and somewhat fossiliferous. The entire drainage of New Home Creek is through Pm strata.

In addition to the above creeks, five other creeks and rivers were examined at various locations in Bates County. However, in each case no chert could be located, and all of these streams traverse the above Pennsylvanian strata.

In sum, although a few chert cobbles were found to exist in three streams on Pennsylvanian strata, chert was scarce overall, supporting Groves' contention that the Cherokee, Marmaton, and Pleasanton Pennsylvanian Groups are virtually devoid of chert. Where chert does occur, it does so in small, highly weathered, poor quality, and essentially unworkable cobbles. Because of this scarcity of knappable chert in these Pennsylvanian strata adjacent to the Truman Reservoir area with its abundance of good quality chert resources, inhabitants of this chertless region probably

procured most of their chipped stone resources from the Truman Reservoir area via trade networks, direct procurement, or seasonal movements and wide-range wanderings. However, some of their chipped stone resources were probably obtained from chert-bearing Pennsylvanian formations located to the northwest.

The nearest chert-bearing Pennsylvanian formations belong to the Kansas City Group (Pkc) and are located far to the northwest of the Truman Reservoir area. This Kansas City Group contains three chert-bearing formations: Winterset, Westerville, and Argentine, respectively. Reid (1980) gives an excellent descriptive and distributional data summary of these previously undescribed Kansas City cherts. The Pkc outcrop along a broad belt which underlies the Kansas City area and extends northeastward across western and northwestern Missouri and northeastern Kansas. According to the Geologic Map of Missouri (Anderson, et al. 1979), the closest sources of Pkc cherts occur 90-100 km west-northwest of the center of the reservoir. Reid (1980: 131), however, notes that these Kansas City formations become decreasingly cherty south of the Kansas City region, 160-170 km northwest of the reservoir. Although both the Osage and South Grand rivers headwater drainages are on Pkc strata and thus some Pkc cherts should occur as redeposited gravel within the reservoir, the long abrasive meandering journey downstream should render the chert small and unknappable. One other chert-bearing Pennsylvanian formation, the Spring Hill, occurs in the Lansing Group (Plp) north of the Missouri River and west of the Kansas City Group (Anderson, et al. 1979).

Other "exotic" types of chert more distant from the Truman Reservoir were also sampled during the past two years for the purposes of building a regional chert-type collection, for comparative purposes with the extensive local chert-type collection made for the Truman Reservoir area (see "Sampling Method"). Small, regional samples of chert were collected from eastern Missouri, Kansas, Oklahoma, Illinois, Kentucky, Tennessee, and Ohio.

CHERT AVAILABILITY AND PROCUREMENT

Before describing in detail chert availability and procurement in the Truman Reservoir, it should be made clear why such a survey or study of chert or any chipped stone resources is important and relevant to archeology. Although some of the following points are mentioned elsewhere in this paper, an explicit summary of the importance and relevance should be made here. First of all, chert utilization is an important archeological aspect to investigate simply because chert was a very important natural resource to stone age people — possibly as important as faunal and

floral resources since lithic resources were often procured and fashioned prior to hunting and gathering faunal and floral species. Thus, it is just as necessary to determine and report on potential chipped stone resources a particular region contains as it is to report on faunal and floral resources in a particular study area. In fact, since lithic resources are more stable and less likely to change through time than faunal or floral resources, they may be considered an even more dependable data source.

Secondly, research on chert resources is relevant and enlightening to other aspects of archeological inquiry. A study of chert resource availability is important not only to a better understanding of prehistoric lithic technology in general, but also to other aspects of cultural behavior such as patterns of raw material procurement and exchange, and site location or settlement pattern analysis. However, environmental conditions of resource availability are not the only factors which affect chert procurement and utilization. Certain cultural factors are also operative such as trade relationships or interaction networks, level of subsistence or settlement patterns in regard to mobility and degree of territorial wandering, and the practice of thermal alteration of siliceous materials. In short, there is an interrelationship between the variability and availability of natural lithic resources and cultural behavior and/or adaptation.

In regard to lithic technology, observational and experimental studies on the quality of locally available chert resources yield important information on the technological and functional potentials and limitations of the particular raw materials. Specific inherent properties of a particular chipped stone material may be better suited for certain manufacturing technologies than others; for example, obsidian is technologically superior for blade production, pressure flaking, and soft hammer percussion than coarser-grained, impure varieties of chert. In the same respect, differential knapping qualities of various chert types may have created a selectivity for the better knapping quality chert types over inferior cherts limited by various properties such as incipient fracture planes or flaws, large fossil inclusions, coarseness, etc. However, certain cultural factors such as heat treatment may alter the less desirable cherts into better quality material. Certain chert types may also be more advantageous functionally than others, holding an edge longer, producing sharper cutting edges, or being able to withstand stronger impacts and pressure; again, heat treatment may alter these properties. Such qualities could be tested experimentally via flint knapping tests, and wear pattern and functional analyses.

A knowledge of chert resource availability and quality also contributes to a better understanding of procurement patterns and exchange relationships. Minimally, a chert survey of a study area should determine whether prehistoric peoples had locally available resources to exploit or were required to obtain non-local, exotic chipped stone resources. A thorough chert survey can determine the amount and type of energy expenditure and/or social relationships needed to procure lithic raw materials. The survey should initially determine the various kinds of chert and the types of sources available, such as stream deposits, glacial deposits, residual deposits, and bedrock outcroppings. The survey may also locate and document aboriginal bedrock quarry areas which require laborious mining techniques or less laborious quarries in residual deposits. On the other hand, if the survey determines that siliceous, chipped stone tool material is absent or is of very poor quality in the research area, a long distance travel, seasonal movement, or complex exchange system of regional scale may have operated to procure and exchange this vital resource. A long range procurement or chert exchange system could be verified by identification of exotic chert among the chipped stone artifacts visually or mineralogically (neutron activation analysis).

An examination of available lithic resources is also important for an understanding of settlement pattern systems. Chert may have been a very important factor or had a negligible effect in settlement location, depending on the availability, quality, and quantity of the chert resources. In regard to availability, the extent and distribution of chert resources are significant factors to consider. Large extensive exposures of chert resources would probably have provided major resources, whereas small limited outcrops would have provided minor resources. The other aspect of availability which may have been an important consideration in settlement location is distribution, or whether chert resources are ubiquitous in a research area or limited to or concentrated in a particular portion of an area.

Thus, the availability of chert resources to the aboriginal flint worker depended upon the various environmental factors (accessibility, quantity, extent, distribution, etc.) particular to the different types of natural sources in which they were manifested and/or upon humanly manipulated cultural sources; very different procurement techniques were associated with these various types of natural and cultural lithic sources. Each type of natural and cultural source available in the Truman Reservoir and its associated procurement technique(s) is presented in the following discussion along with different modes of procurement and depositional patterns of chert-artifacts manifested in the archeological record, a proposed economizing hypothesis, and certain factors affecting procurement practices.

Natural Chert Sources

Although modified by certain limiting or conditioning environmental and social factors discussed later, there were three distinct types of natural chert sources potentially available to prehistoric peoples in the Truman Reservoir area, each manifested in a different context. These were: (1) _in situ_ bedrock outcroppings, (2) residual chert deposits, (3) stream redeposits (gravel bars).

In situ bedrock chert refers to nodules or layers of chert still embedded or consolidated in a limestone matrix (Plate 5a). Bedrock outcroppings can be found in natural stream cuts (cut banks), earth-slide exposures, or hillside outcropping resulting from little or no regolith. Procurement of _in situ_ bedrock chert would involve laborious mining or quarrying into the surrounding limestone matrix to dislodge the chert. Such quarrying has been documented in the Flint Ridge area of east-central Ohio where pits up to eight meters deep were sunk through the soil overburden and into the flint-bearing bedrock (Holmes 1919: 173-181) and at the Mill Creek quarries in southern Illinois where similar quarrying techniques were employed (Phillips 1900: 37-52). Gregg and Grybush (1976: 189-192) summarize evidence for quarrying into bedrock via the fire and water technique.

Residual chert refers to chert nodules removed from the original limestone matrix via chemical and physical weathering (Plate 5b). These free nodules occur on or in the ground and are often referred to as residual "float." Residual chert may be procured directly from the ground surface with the least amount of effort or less weathered, better quality subsurface residuum may be quarried from the regolith below the frost-line, which fluctuates between 5 and 30 cm in the Truman Reservoir area (Decker 1980b). The depth of the frost-line or freezing zone is an important factor in the weathering, and thus quality, of residual chert. At numerous locations throughout the Truman Reservoir, significant differences were noted between the overall quality of surface residuum as compared to subsurface residuum. A much higher percentage of surface residual nodules than subsurface nodules exhibited cracks, fractures, and other internal flaws. Although the depth of the frost-line would have been affected over the past 12,000 years by various environmental factors such as climatic change, vegetation cover, soil type and depth, and topography or slope, the following data are generally thought to be applicable to most areas in the Truman Reservoir. These data were obtained over the last fourteen years from a recording device under a grass cover in Lawrence County near Mt. Vernon, (southwest) Missouri. The data in Table 2 show that during

TABLE 2

Frost-Line Depth During Winter Months (December-February) of 1967-1980

Date	Depth of Penetration <10 cm	At least 10 cm	At least 20 cm
1967	X		
1968		X	
1969		X	
1970	X		
1971	X		
1972	X		
1973	X		
1974	X		
1975	X		
1976		X	
1977			X
1978			X
1979			X
1980	X		

Data Source: Unpublished data, Department of Atmospheric Science, University of Missouri

eight out of the last fourteen years the frost-line did not even penetrate as deep as 10 cm; during three of the past fourteen years it penetrated at least 10 cm; and during only three years did it penetrate as deep as 20 cm. The frost-line would never have penetrated as deep as 50 cm during climatic conditions similar to those of modern times (Wayne Decker, personal communication).

Since chert that comes into direct contact with fire usually cracks and even shatters, the repeated occurrence of intense grassland and "crown" forest fires is another reason why it was probably advantageous to quarry into the subsoil or below the frost-line for residual chert. This may be an additional reason why during the Chert Survey a much higher percentage of surface residual nodules exhibited fractures, spalling, and other flaws than subsurface residual nodules.

Ives (1975: 7) reports that the famous Crescent quarries in eastern Missouri were probably the result of shallow quarrying for subsurface residual Burlington chert. Reid (1978: 65-66) also believes this technique was the one best suited and most economical for procuring large quantities of shallowly-buried Kansas City cherts; he documents a large quarry for residual Westerville chert 4 km north of the Nebo Hill site. Turner (1954: 10-12) referred to two residual quarries in Polk County south of the Truman Reservoir. These quarries were visited during the 1979 Chert Survey of the Truman Reservoir and several cores and large and small flakes made from Burlington chert were found; however, no pits or depressions were located, probably due to cultivation and/or bulldozing of the quarry areas by previous owners.

Redeposited chert in stream bed gravel bars is chert which has been transported and secondarily redeposited by stream action (Plate 5d). These alluvial gravels, which have been eroded from primarily residual sources upstream, typically choke small intermittent streams and are especially concentrated at the confluences of low order streams.

Redeposited chert is identified by its water-worn smooth abrasion surface or cortex. Unfortunately, most well-made tools knapped from stream chert seldom have this water-worn cortex left on the artifact, thus making precise quantitative analysis of redeposited chert virtually impossible. Redeposited chert is procured directly from the stream bed gravel bars with a minimal expenditure of effort; however, the majority of stream chert has been more extensively weathered than either residual or bedrock chert due to freezing and fluvial corrasion and corrosion, which causes hydration and the development of a brown patina. Meyers (1970: 34) speculated that stream bed gravels were probably the major chert source in the lower Illinois Valley, although

he did not sample and test them. A test was conducted on stream deposited chert nodules in a large gravel bar of a tributary of the Osage River in the southwest portion of Truman Reservoir to determine the quality and quantity of the available redeposited cherts (see Appendix A: Stream Deposited Chert Test). It was concluded that although stream deposited chert should have provided a viable, usually readily accessible, and virtually inexhaustible supply of chert in this particular area, the quality and quantity of the nodules vary widely according to chert type.

Cultural Chert Source

Another chert source available to prehistoric flint knappers due to cultural activity is "exotic" chert derived from either long distance travel or extensive trade systems. Exotic cherts from distant sources, which may have served various technological, ideological, or sociological functions, may have been procured directly via overland or waterway travel or through complex trade networks involving down-the-line exchange. Exotic cherts may have played a large or small role in chert procurement depending on the availability or presence/absence of local natural resources and social contacts. The identification of the total range of variations within the local cherts should facilitate the identification of exotic cherts. For detailed aspects of prehistoric exhcange networks, see Earle and Ericson (1977).

Although the above natural and cultural sources were potentially available to aboriginal groups in the Truman Reservoir, procurement of chert from these sources was probably tempered by various limiting or conditioning environmental and social factors such as rugged topography, water barriers, amount of source exposure, volume of exotic chert exchange, and social territorial hostilities.

Modes of Procurement

Luedtke (1976) recognizes two modes of lithic procurement: direct and indirect; these terms are slightly redefined here. Direct procurement is the direct removal of raw materials from a natural source (bedrock, residual deposits, stream deposits) and is divided into two types — casual and deliberate. Casual direct procurement refers to resources obtained while pursuing other activities or during seasonal movements without being a planned or predetermined special activity. The procured material would tend to be in small amounts and probably represent good quality material encountered accidentally. Deliberate direct procurement refers to predetermined or planned special trips to natural sources to procure large amounts of raw materials for reduction purposes.

Indirect procurement refers to obtaining raw material through the mediation of an individual or group of individuals and falls within the realm of social interaction and exchange systems (a cultural chert source). The exchanged items are usually preforms or finished artifacts made of exotic raw material from distant sources and are, thus, generally the most valuable tools possessed. Because of this they are often relegated to ceremonial or limited use and tend to be maximally utilized through recycling and maintenance.

Local vs. Non-Local and Exotic Procurement and Depositional Patterns

Today, trace element or neutron activation analysis enables the archeologist to identify and correlate local and non-local or exotic cherts to specific quarry areas. This, of course, is useful in helping determine the procurement patterns of local vs. non-local or exotic cherts. Work in this area (Griffin *et al*. 1969; Ives 1975; Luedtke 1978) indicates that geochemical variability between areal lithic resources does exist and that their differentiation is possible.

Depositional patterns of non-local and exotic chert artifacts are different from those of locally procured and utilized chert artifacts and, therefore, each type is manifested differently in the archeological record. Non-local or exotic chert resources, which must be derived through certain cultural processes, may have been procured by prehistoric peoples: (1) by direct long distance procurement expeditions, (2) through extensive trade networks involving down-the-line exchange by neighboring groups, or (3) if nomadic hunter-gatherers, via seasonal or periodic movements and wide-range wanderings. In each case, there are certain expected patterns of deposition and occurrence of non-local and exotic chert artifacts. For instance, a higher percentage of non-local and exotic cherts should occur in tools than in debris, and in the small amount of non-local and exotic chert debris that does exist, there should be a higher percentage of tertiary flakes, produced by finishing, retouching, or resharpening tools, than primary or secondary flakes. The above patterns are predictable because the initial decortication debris of non-local chert would be deposited at the distant procurement or workshop sites, and only the time-consuming well-made tools (such as projectile points) are expected to be conserved and transported from site to site, eventually to be deposited on grounds far from the original chert source.

Locally procured and utilized chert artifacts, on the other hand, should be represented archeologically at the source site, nearby workshop, and/or habitation site by a

high percentage of decortication, primary, and secondary flakes and cores. Thus, there is a higher ratio of flakes and debris than tools (although many tools representing the local chert sources should also be present).

Economizing Hypothesis

It is hypothesized here that procurement and utilization of chert exhibited in artifact collections from the Truman Reservoir will be directly related or proportional to the availability of and proximity to particular chert resources. This hypothesis is based on the Principle of Least Effort or Zipf's Law (Zipf 1949: 6-7), the "mini-max" or economizing hypothesis (Plog and Hill 1971: 12), and site catchment analysis. The theory behind site catchment analysis maintains that the procurement zone of natural resources usually occurs within reasonable walking distance of a given habitation center, which minimizes the ratio of energy expended to energy procured; it supposes that those natural resources most likely exploited lie within economic range of individual sites (Flannery 1976: 103; Vita-Finzi and Higgs 1970: 5; Roper 1979: 121). Since a site is usually located on or very near one particular type of chert resource, it is expected that the majority of artifacts from that site will represent the local resource. Where two or more chert types occur equidistant from a site, the quality, quantity, accessibility, and availability of each individual chert resource should be the determining factors in procurement.

Factors Affecting Procurement

Although the above model is proposed, it is recognized that various environmental, social, and physical factors probably affected chert procurement to some degree, thus altering or negating the direct relationship postulated between chert availability and utilization. An attempt will be made here to evaluate these environmental, social, and physical factors and determine to what extent these factors modify the availability-utilization (or economizing) hypothesis.

Environmental factors include resource inaccessibility due to natural barriers such as rugged topography, deep water, and amount of formation exposure governed by slope gradient, colluvium, and alluvium. These may have changed dramatically over the 12,000 years of prehistory in the Truman Reservoir. Mantling regolithic overburden buries much of the areal extent of the chert-bearing formations on gentle slopes and flat uplands, while colluvium masks some steep slope exposures and alluvium buries bottomland outcrops under terrace, alluvial fan, and floodplain deposits. Two structural features of each formation that should have some bearing on the abundance and availability of the cherts are

the thickness of each chert-bearing formation, and the percentage of chert occurring in each formation. These two factors will be governed in turn by the amount and type of source exposure of each formation.

Social factors affecting chert procurement are various economic considerations, trade in exotic cherts, hostilities between neighboring groups, population size, and type of subsistence-settlement systems or level of cultural complexity. Hunter-gatherers are often nomadic and could have exploited a wide range of lithic resources, whereas horticulturists were usually relatively sedentary peoples and would be more likely to exploit local resources. They would also, however, be more likely to engage in exchange or trade relations. Francis (1980: 11) predicts such a change in procurement practices between Paleo-Indian and Archaic times in Wyoming; she expects that distances from which raw materials were procured should decrease through time.

Technological and functional potentials and limitations of each type of chert are possible physical factors. From intensive field experience at eleven separate locations scattered throughout the Truman Reservoir area, it was found that, as a general rule, Jefferson City chert occurs as a finer-grained, well-consolidated, better quality material than either of the two Mississippian cherts. However, as always, there are exceptions to the rule where Chouteau and Burlington cherts occur locally as good quality material equal to any Jefferson City chert.

Technologically, from personal experience in flint knapping, I have noticed varying knapping qualities in the three dominant cherts due to certain inherent physical properties — Jefferson City being easier to knap than most Chouteau or Burlington chert. Whereas Jefferson City chert is usually fine-grained, has a smooth conchoidal fracture, and other glass-like properties which induce quick, easy, and above all accurate fracture, Chouteau chert is usually laden with incipient fracture planes and weathering cracks, and Burlington chert is often hard, porous, highly weathered, and contains large obstructing fossils. These properties may have created a preference among aboriginal flint workers for one chert type (Ojc) over another, introducing selectivity into procurement. On the other hand, it has been demonstrated that heat treatment improves the working quality of chert (e.g., Crabtree and Butler 1964: 1; Crabtree 1966: 17; Rick 1978: 44-53), and thus this process may have been used to improve the less desirable cherts.

Functionally, it may be the case that certain cherts are better suited for particular tool functions than others. For example, a slightly harder and coarser-grained chert may hold an edge better and thus work better and last longer

during scraping activities such as processing hides; fine-grained chert may produce tools with sharper cutting edges to be used as knives; and chert with greater compressive strength may better withstand impact and be preferred for projectile point manufacture. Rick (1978: 54, 62) found that unheated and heat treated tools were differentially useful in different functional contexts: although initially sharper, the edges of heat-altered tools dulled quickly in high stress use, whereas unheated tool edges were more durable. He posits that unaltered raw chert is functionally better in situations of intense stress and that heat treated chert is functionally better in cutting, piercing, and light-duty scraping activities.

In addition to the above factors, artifact collection strategies may have an influence on data pertaining to surface collected artifacts. Three stages of archeological reconnaissance were conducted within the Truman Reservoir from 1975-1979 by the University of Missouri. Stage 1 was an intensive survey which collected most all of the artifacts from the surface of each site, whereas during Stages 2 and 3 only the more diagnostic artifacts were generally collected.

There is also the distinct possibility that well-made tools and the most important tools in particular, are curated and moved from one place to another (Binford 1976: 299-351) and are thus not accurate reflections of artifacts actually procured, manufactured, or used at any particular site. Curated artifacts were usually recycled or maintained, and archeological evidence of these activities are reworked broken tools (often for a different function), multiply resharpened tools, and small retouch flakes.

1979 CHERT SURVEY

The following section discusses the operationalization of the Chert Survey of the Harry S. Truman Reservoir during the summer of 1979. Included in this discussion are: the strategy developed to accomplish the lithic resource survey, the survey form used to record chert sites, field equipment, the general survey procedure and sampling method used in conducting the actual field survey, the means of recording all chert or archeological sites located during the survey, chert percentage predictions, and a discussion of analysis.

Chert Survey Strategy

In order to fulfill the first, second, and third objectives of this study, it was necessary to construct a sufficient sampling survey strategy to determine the availability, distribution, quality, quantity, and accessibility of the different types of cherts and chert sources at various locations throughout the reservoir. To accomplish this task it

was decided to concentrate on intensively surveying and assessing the resources within a demarcated area or "territory" surrounding several major archeological sites. The territory delimited was a circle 1 km in radius centered on a selected site. The greatest quantity of lithic resources is postulated to have been derived from within this area. In addition to being the area most likely to have been exploited the most, time was a factor in limiting the size of the territory-circle to be surveyed. It was deemed unfeasible to attempt to intensively survey an area greater than 1 km radius around at least 10 territories projected for the nine week period field season. However, the survey of chert resources was not strictly limited to only those resources within each territory. When it was obvious that different chert types were likely to exist immediately outside a particular territory, a survey was also made of the extra-territorial areas. The ten chert resource territories to be discussed later are referred to and designated by underlining the site number of the archeological site on which it centered (e.g., BE676).

The term territory has been used by Roper (1979: 124) to refer to an analytical unit used for examining the areal resources immediately accessible to a site's inhabitants. This analytical term is used in this study instead of catchment, which is a behavioral unit (Roper 1979: 124) referring to the total area from which the contents of a site were derived (Higgs 1975: ix).

The Chert Survey had two additional objectives related to other Truman Project goals and research: to procure chert from the same resources exploited by prehistoric peoples for flint knapping (Ray 1981), use-wear (Briney 1981), and heat treatment (Ray 1981) experiments and also for possible future trace element analysis; and to look for and survey any prehistoric quarries, lithic reduction sites, or other chert-related cultural activities. Although reported quarries in the reservoir area (Turner 1954: 10-12) were checked, no definite bedrock or residual quarries were located, possibly due to natural and cultural (plow agriculture) erosive processes or different procurement practices such as exploitation of surface residual chert and/or redeposited stream bed chert.

Chert Site Survey Form

Before going into the field, a chert survey form was devised for recording field data on each chert sample collection site located. Headings incorporated into the form were drawn from the Harry S. Truman Reservoir Archeological Site Survey Form and the Macoupin Chert Survey Form used by Meyers (1970: 16) plus additions of my own.

Included on the Harry S. Truman Reservoir Chert Site Survey Form (Fig. 6) were the site number, date, surveyors, recorder or survey leader, legal location, the distance and direction from the nearest landmark, quadrangle, county, elevation, closest watersource, stream rank, type of chert source (stream cut or bedrock, residuum, stream deposit, quarry, roadcut, historic quarry, and other), formation name (chert type), outcrop-gravel bar thickness and extent when applicable, a percentage estimate of the chert density, accessibility, a detailed description of the chert, photograph frame number and direction, a remarks section, and a sketch of unique or unusual chert sites on the reverse side. The particular territory, designated by encircling the selected archeological site number, and the quadrant of the territory being surveyed were written on the form in the top left corner.

All of the above headings are self-explanatory and need no further clarification here except for site number, chert density estimate, and chert description. The notation system devised for designating the proveniences for bedrock and residual chert sites (site number) included the county abbreviation, the geologic symbol for the formation from which the chert sample was derived, and successive Arabic numbers (e.g., BE Ojc 7). However, a slightly different system had to be used for designating stream deposited sites, which included the county abbreviation, an abbreviation for stream, successive Arabic number, and then successive formation symbols represented in the gravel deposits in parentheses, for example, BE Str 2 (Ojc, Mk, Mo). Any archeological site found during the Chert Survey was given an archeological field and site number and was collected for a sample of the chert types represented in the artifacts.

The percentage estimates of the chert densities for residual chert sites may be over-estimated since a subjective estimation of the chert density in the original bedrock is very difficult to make from residual float once the chert has been removed from its matrix and has accumulated on the surface for several millennia; factors such as ground cover and surficial erosion also adversely affect attempts at accurate estimations. Nevertheless, the subjective density estimates should be relatively comparable from site to site since the estimates were made in a consistent manner by one individual.

The chert description included such remarks as color, nodular form(s), degree of weathering, distinguishing characteristics, and most important, an impression of the quality or knappability of the chert being sampled. The chert at each site was tested by removing a few flakes from several nodules with a rock hammer and then the quality or knappability of the chert was graded according to the criteria in

HARRY S. TRUMAN RESERVOIR

CHERT SITE SURVEY FORM

Site No. ____________________ Date ____________________

Surveyors ______________________________ Recorded by ________________

Legal Location ____1/4 ____1/4 ____1/4 Sec ____ T ____ R ____

Landmark: located __________ __________ from ____________________
(distance) (direction) (landmark)

Quadrangle ____________________ County ____________ Elevation _______

Closest Watersource _______________________ Stream Rank ________

Type of Chert Source: Stream cut Residuum Stream Deposit

Quarry Roadcut Historic Quarry Other __________________

Formation - Chert Type(s) ____

Outcrop-Gravel Bar: Thickness ___________' Extent ______________'

Chert Density (% estimate): ________ Accessibility ________________

Chert Description (color, nodular form, weathering, etc):

Photographs: Frame No. ____________________ Direction ________________

Remarks:

Figure 6. Harry S. Truman Reservoir Chert Site Survey Form.

Table 3. Although the criteria may be somewhat subjective, these quality measures were based on personal experience as an amateur flint knapper. All of the quality determinations were made by the author.

Field Equipment

The necessary field equipment used to locate and sample chert sources in the field included: chert site survey forms, 7.5-minute U.S.G.S. quadrangle maps, the 1979 Geologic Map of Missouri, clipboard, pocket-sized note pad and pens, an engineer's compass, hand lens, rock hammer, safety glasses, various sized double-lined sample bags, burlap sacks for carrying chert samples, 35 mm camera and film, meter stick, and snake bite kit. A valuable instrument unavailable to us but highly recommended for future chert surveys is an altimeter to precisely determine outcrop elevations.

Survey Procedure

Seven sites excavated between 1977 and 1979 were chosen for survey of chert resources within a 1 km radius territory. An additional three surface sites were selected in order to sample some portions of the reservoir not represented by the seven excavated sites. The ten sites chosen had a maximum distance between them of approximately 40 km but an average distance of about 15 km (Fig. 7). The chert resources within 1 km radius around Rodgers Shelter was an eleventh territory surveyed during the summer of 1979; however, this territory has been omitted since artifact collections from the shelter were not analyzed in this study. Kay et al. (1978: Ch. 7, p. 2-3) give a brief account of the chert types available near Rodgers Shelter.

First, each territory was divided into quadrants. Since each of the ten territories surveyed was bisected by the stream by which the site was located and since other natural topographic features usually further subdivided the territories, naturally defined quadrants or sections were identified and labelled according to the section of the circle (NE, SW, etc.) they occupied. After the territory was divided into quadrants, the topography within each quadrant was analyzed for areas that would likely yield significant data on the different types of cherts and sources available (such as highest and lowest points, cut banks, and stream gravel bars). A meandering course was then taken through all portions of each quadrant, sampling sources along this predetermined route. The chert resources within each quadrant were summarized after the survey of the particular quadrant was completed.

The technique employed to delineate formation contacts was either to descend a slope or hillside noting the point

TABLE 3

Chert Quality Criteria (Knappability)

Quality	Criteria
Very poor (VP)	Unknappable, very poor conchoidal fracture, sandy or grainy, extensive inclusions and/or incipient fractures
Poor (P)	Practically unknappable, undesirable, full of inclusions and/or incipient fractures, no control over flaking
Fair (F)	Knappable but not quality material, some inclusions and/or fracture planes, average, some control over flaking
Good (G)	Quality material, very few inclusions and/or incipient fractures, good conchoidal fracture, control over flaking
Excellent (E)	Pure material with no inclusions or fracture planes, fine-grained, choice material (best available), excellent control over flaking

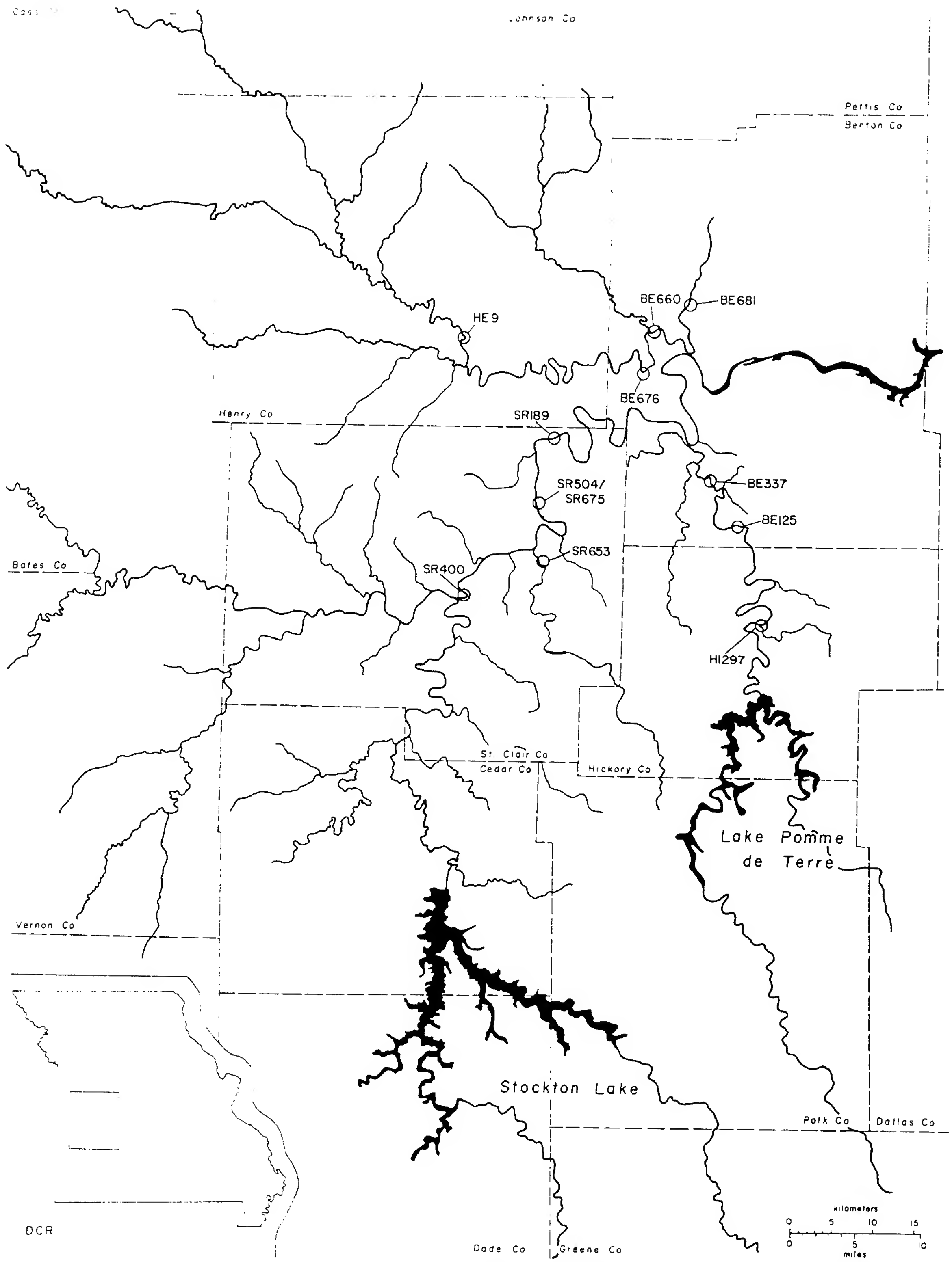

Figure 7. Distribution of Chert Survey territories within Truman Reservoir.

at which the chert residuum of the underlying formation first began to appear or, conversely, to ascend a slope noting the point at which the chert of the lower formation disappeared. In each case, the starting point from the foot or top of a hill was dictated by the location of the access road into the territory. The preferred approach was to descend a slope since downslope residuum of the overlying formations was minimized. Besides the transition from residual float of one type of chert to another, other clues to the contact point between formations are: changes in the degree of slope, structural benches, and re-entrants formed by the erosion of the less resistant adjacent formation. An often obvious contact in the reservoir is between the Chouteau and Burlington formations, separated by the weak, poorly consolidated Northview shale formation (Plate 5c).

Sampling Method

Once the contact point was located, chert samples were taken from each formation. Approximately 20-30 minutes were spent at each new site, striking off fresh flakes from several nodules until a sample weighing about 1-1.5 kilograms had accumulated. A point was made to sample not only the typical chert from the formation and all types of variations within the chert, which at times tended to be quite large, but also several pieces of the limestone or dolomite. The sample bag(s) was (were) then appropriately labelled with the territory number, quadrant, site number, and date and placed into the burlap sack to be carried to the next site or back to the vehicle. The chert site form was filled out in the field and a photograph was often taken of the site. The intensive sampling conducted within eleven territories during the 1979 Chert Survey, built an extensive type collection of the cherts available within and adjacent to the Truman Reservoir. These chert samples are curated with the Truman Reservoir collections at the University of Missouri-Columbia.

All sites located during the 1979 Chert Survey were carefully plotted on United States Geological Survey 7.5-minute topographic maps. Unfortunately, only two geologic maps are presently available for the Truman Reservoir area — one for the Shawnee Bend Quadrangle (McMillen 1950) and one for the Weaubleau Creek area (Beveridge 1951). Of the eleven chert resource territories surveyed during the summer of 1979, only three (BE660, BE676, BE681) fell within one of these geologically mapped areas, *viz.*, the Shawnee Bend Quadrangle mapped by Dan McMillen in 1950 for a thesis in geology. Although McMillen's geologic map was helpful in delimiting and sampling different formations at certain locations, it was useful in only a limited, general way because many inaccuracies were noted on his map due to the generalization of

formation outcrops along certain contour elevations. Thus, a rechecking and often remapping of the geologic formations within the Shawnee Bend chert resource territories plus a totally new mapping of the geologic formations in the other eight territories was necessary during the 1979 Chert Survey.

Roadcuts and historic quarries were de-emphasized during the Chert Survey in favor of the natural sources potentially available to prehistoric people; however, some were sampled and studied, mainly for observing stratigraphic relationships, formation thicknesses, and chert densities.

A survey of chert resources requires a good background in geology and geomorphology. Both crew members of the 1979 Chert Resources Survey had such a background. Although both are graduate students in archeology, Robert Skrivan is well-trained in geology with a minor in that field, and I have a minor in physical geography with a strong background in geology and geomorphology.

Archeological Sites

During the course of the Chert Survey, twenty-nine archeological sites were encountered on or about various chert sites. Of these twenty-nine archeological sites, six were previously recorded sites that were resurveyed and twenty-three were previously unknown sites. After sampling and recording the particular chert site, the archeological site was surveyed and all surface artifacts were collected unless the archeological site was extensive. In cases where there was an extensive/intensive lithic scatter, an effort was made to collect a small representative sample of the different chert types occurring in the artifacts. However, since there was no structured sampling strategy, these results may be biased. The unrecorded sites were subsequently recorded on standard Harry S. Truman Archeological Site Survey Forms. All archeological sites located on chert sites are cross-listed under the "remarks" sections of the respective forms. They are described along with other sites recorded by regular survey crews (Roper 1981).

Small "isolated find" sites of only a few undiagnostic artifacts were only noted as to chert type and generally left undisturbed. However, these small isolated finds are important as they often indicate transportation of raw material upslope. In many instances small quantities of Ojc artifacts were found on top of the stratigraphically higher Mk and Mo formations. Because of the usually small and sometimes selective sample of the Chert Survey archeological sites and isolated finds, analysis of these collections will involve only the identification and discussion of chert types.

Chert Percentage Predictions

Percentage predictions of expected chert frequencies in the artifact collections of the seven excavated and three surface sites were carefully calculated and based on the chert resources available within each territory (1 km radius around each site). The specific factors considered in calculating the percentage predictions were: (1) type of chert sources present, (2) chert density or quantity at the chert sites, (3) chert quality, (4) accessibility of the chert sources, and (5) outcrop extent (or distribution) and thicknesses of the exposed chert-bearing formations. The percentage predictions of five territories required revision after additional significant chert resources outside the 1 km radius territories were considered. The original and revised predictions are presented in Table 4.

Analysis

The analysis of chert-artifacts collected from the ten sites selected for the resource territory surveys fulfills the fourth and final objective of this study: to determine the utilization patterns of chert resources, so that they can be related to the previously determined availability, quality, and location of the chert resources.

The debris and most of the tools from the ten sites were cataloged, described, and classified by Truman Project laboratory workers according to the *Harry S. Truman Archeological Project Lithic Laboratory Procedures Manual* (Reagan *et al.* 1979). Debris and tool artifact category abbreviations used in tables in this paper are defined in this manual. The projectile points were classified and typed by Susan K. Goldberg and Donna C. Roper (1981).

The second and most important part of the analysis for the purposes of this paper was to chert-type or identify the kind of chert from which the artifacts were manufactured. This analysis, which determined the actual differential chert utilization, was conducted by the author for the following six sites: 23BE337, 23HE9, 23HI297, 23SR189, 23SR400, 23SR653, and I assume full responsibility for this chert identification and utilization analysis. The chert identification and utilization analysis for the four remaining sites was conducted by other Truman personnel. The chert identification for 23BE660, 23BE676, 23BE681, and 23SR504-23SR675 was conducted by Truman Project laboratory workers who are responsible for this chert-typing. An examination of the differential chert utilization at these sites is discussed in the individual reports on these sites. However, descriptions of the chert resources around each of these sites, as determined by the Chert Survey of the respective territories, are included in the present paper.

TABLE 4

Chert Percentage Predictions

	Initial Percentage (%) Predictions			Revised Percentage (%) Predictions				
	Ojc	Mk	Mo	Or	Ojc	Mk	Mo	Mm
23BE337	78	5	17					
23BE660	80	10	10					
23BE676	75	10	15					
23BE681	85	10	5					
23HE9	0	0	100					
23HI297	97	1	2	0.5	90	3	6.5	
23SR189	2	83	15		20	60	20	
23SR504 23SR675	85	10	5		75	20	5	
23SR400	7	13	80		21	29	49	1
23SR653	10	30	60		22	33	45	

The chert identification analysis (of the six sites presented here) was conducted on all of the artifacts from the three surface sites (23HE9, 23SR400, 23SR653) and on a representative sample of the whole collection in the case of the three excavated sites with a multitude of artifacts (23BE337, 23HI297, 23SR189). The sample size of these large sites was dictated by the amount of analysis considered to be feasible within the available time and financial resources; still, at least 10% of the entire artifact collection from these extensive sites were chert-typed. Although these samples are not statistically random, the only conscious bias in the selection process was toward a coverage of the range of temporal and spatial dimensions represented at the sites and are therefore believed to be adequate for determining chert resource utilization patterns.

A few analytic terms used in this report need to be defined here. "Local" chert pertains to those chert types that are located within or very near the particular chert territory being discussed. "Non-local" refers to chert that is not immediately available within or adjacent to a particular chert territory but which is available in the Truman Reservoir area. "Exotic" refers to chert external to the Truman Reservoir area or at least 50 km distant from its boundaries. In reference to chert-typing, "indeterminant" refers to a piece of chert that is unidentifiable macro- or microscopically because it is: (1) a highly weathered and chemically altered cortex fragment (including highly patinated creek gravel); (2) cream white with no diagnostic features; or (3) too small for identification. The tool and debris technological and morphological classes used in this analysis are defined in the *Harry S. Truman Archeological Project Lithic Laboratory Procedures Manual* (Reagan *et al*. 1979).

The following section presents the two-fold analyses of several of the chert resource territories – the first half on chert availability obtained from the Chert Survey and the second half on the analysis of the artifactual chert data or utilization of chert resources.

CHERT RESOURCE TERRITORY STUDIES

This section deals with the actual analyses of the availability and utilization patterns of chipped stone resources within the ten chert territory study areas. Six of the following chert resource territory studies will consist of two parts: First, an intensive Chert Survey of each territory which determined the availability of the local chert resources will be presented, and second, a chert utilization analysis of all or a sample of the artifacts from a selected site will be discussed, revealing chert utilization patterns at that site. The last four studies consist only of the Chert Survey and availability section.

The first part of these chert resource studies is considered an in-depth treatment of the availability of the chert resources present in a particular territory. The second part of the studies or the artifactual analysis sections will emphasize the overall utilization patterns exhibited by the examined artifact collections and whether they support the economizing hypothesis and certain expected patterns (predicted percentages) of utilization based on the Chert Survey. Also examined will be the relationship of artifact types (debris/tool) with chert types and spatial and temporal differences in utilization (such as between levels in a square and between two or more squares). Although mentioned and briefly elaborated on at times, heat treatment practices, the utilization of redeposited stream bed chert, and relationships between chert types and specific artifact morphological or technological categories will not be discussed in any detail. More intensive studies dealing with these aspects should be made since such investigations might determine additional behavioral patterns associated with chert utilization.

23BE337

BE337 CHERT SURVEY (AVAILABILITY)

Territory BE337 (Fig. 8) is located in Benton County in the extreme southeastern corner of the Warsaw West Quadrangle, 2.3 km southeast of the confluence of Little Pomme de Terre River and the Pomme de Terre River. The territory is bisected northwest-southeast by the Pomme de Terre River. The river's floodplain, which is 0.7 km wide, was inundated at the time of study and thus the bottomland and creek beds were unsurveyable. The northeastern portion of BE337 (NE quadrant) encompasses a steep cut bank and flat upland area. The NW quadrant was all floodplain, therefore, unsurveyable. Rerouted Highway 83 which bisects a ridge in the southern half of the territory defines the SE and SW quadrants.

Seventeen chert sites were sampled and recorded within BE337. However, because of the excellent stratigraphic view presented in two fresh roadcuts on either end of the Highway 83 bridge and the limited terrain above pool level, seven of the seventeen chert sites were positioned in roadcuts. The remaining ten chert sites (four Ojc, three Mk, three Mo) were all sampled from residuum, the most abundant chert source. All three chert types outcrop in each quadrant but in varying quantities.

The Ojc chert in BE337 was usually variable in quality in each quadrant – from rough quartzose, weathered, and fractured nodules to smooth, glassy, fine-grained, good knappable material. At most sites at least one-third of the total residual chert was of good quality with one-half of the total fair quality and the rest poor quality.

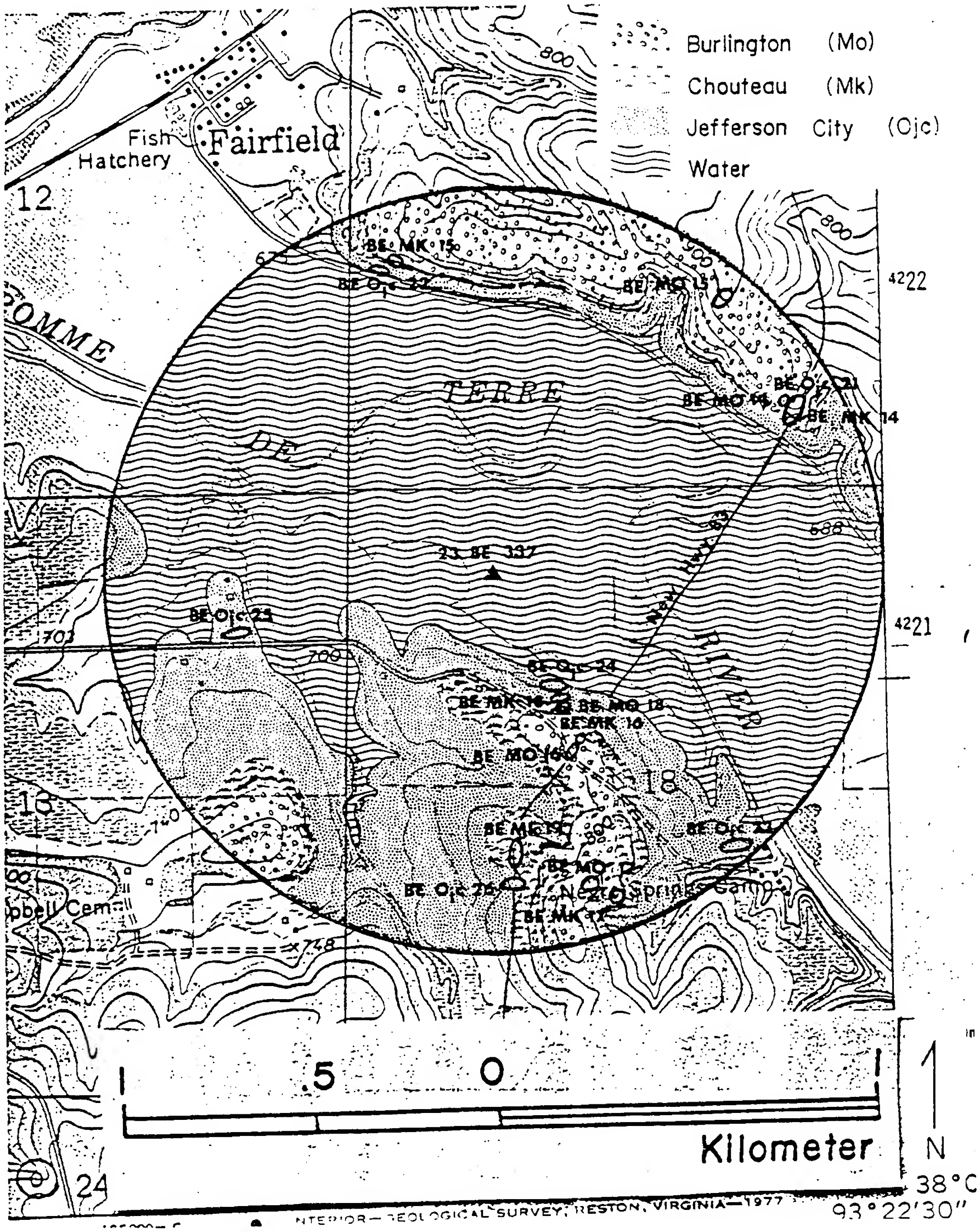

Figure 8. Chert Survey of territory BE337.

Almost all the Mk chert sampled in each quadrant of BE337 was rough quality material with a blocky structure that was usually weathered and fractured along incipient planes. As such, it was basically unknappable.

The Mo chert in this territory was variable in quality depending on location. In the NE quadrant, Mo was generally highly weathered, although it occurred in rather large nodules and in large quantities; however, there were small isolated finds of good quality Mo chert along the ridge above the cut bank. Basically, only basal Mo outcrops in the SE quadrant which is almost invariably poorer quality chert than Mo proper. A good source of some excellent quality Mo chert was located in the SW quadrant on the ridge top at chert site BE Mo 18 – approximately 10-15% of the total 35-40% chert density. The rest of the Mo was coarser-grained and weathered.

The Ojc, Mk, and Mo formations outcrop at varying elevations within BE337. Most of the strata dip to the SW at about a 5^{o} angle; however, in a roadcut in the southernmost portion of the territory the strata are inclined upward to the south. For example, the Ojc, Mk, and Mo formations outcrop about 40' lower at the western edge of the NE quadrant than at the eastern edge, and the Ojc-Mk contact is about 5-10' higher in the southern half of the SE quadrant than it is in the northern half of the same quadrant.

There is a series of undulating synclines and anticlines that have developed in this area which may account for the varying elevations of the formations. Gentle to moderate synclinal and anticlinal folds are observable in Highway 83 roadcuts north, south, and within BE337 (Plate 6a and 6b). In addition to folding, complex faulting probably has occured. Significant faulting was recorded in a roadcut next to the Little Pomme de Terre River approximately 5 km southwest of BE337 (Plate 6c).

Percentage predictions of expected chert frequencies in excavated artifacts from 23BE337 were calculated after careful consideration of information on chert availability, quality, and quantity obtained from the Chert Survey. Based on this field evidence, Ojc chert was predicted to occur in 78% of the artifacts, Mk chert to occur in 5% of the artifacts, and Mo chert to occur in 17% of the artifacts.

Two relatively large archeological sites and two isolated finds were found during the survey of BE337. Within chert site BE Ojc 23, a very heavy concentration of artifacts was located in an old road bed and designated 23BE900. The debris at this site was so dense that only a small percentage could be sampled. However, since there was no structured sampling strategy, the results may be biased.

Of the fifty-one artifacts collected, Ojc was by far the most common type of chert utilized, making up 88.2% (forty-five artifacts) of the total sample. Burlington chert was represented by five artifacts (9.8%) and Mk chert by only one flake (2.0%).

Near the highest point in the SE quadrant at chert site BE Mo 17, a fairly heavy lithic scatter was collected and designated 23BE901. The fifty-four artifacts from this site also revealed a clear preference for and heavy utilization of Ojc chert. Fifty-one artifacts were made of Ojc and the remaining three artifacts were knapped from Mo chert; Mk chert was not represented in this collection. This finding is significant in that an overwhelming majority (94.4%) of the artifacts recovered from this Mo ridge top were manufactured from Ojc chert located in the valley and on the lower sides of the ridge.

The two isolated finds were both located on top of the Mo formation in the NE quadrant. At chert site BE Mo 14, three Ojc flakes and two Mo flakes were found, and at BE Mo 15 a few Ojc flakes, an Ojc nodule, and one Mo flake were noted. The presence of Ojc chert at these isolated finds is additional evidence of not only utilization but transportation of significant amounts of Ojc chert to higher grounds within the territory.

23BE337 ARTIFACTUAL ANALYSIS (UTILIZATION)

Archeological Site 23BE337 is a tested site at which excavation of twenty-four 1 x 1 m squares yielded a total of 14,475 artifacts. Artifacts from three squares were selected for chert analysis. Square 60S 79E was excavated to a depth of 70 cm and contained 542 artifacts; square 62S 83E was excavated to a depth of 60 cm and contained 613 artifacts; and square 66S 83E was excavated to a depth of 50 cm and contained 358 artifacts. The combined number of artifacts from all three squares which were chert typed for the purposes of this analysis totaled 1,513 or 10.5% of the 14,475 excavated artifacts from 23BE337. The data are presented in Table 5.

In an effort to determine whether there was a significant temporal difference in chert utilization at 23BE337, a chi-square comparison of chert type between the upper and lower components was made for each square (Table 6). Based upon diagnostic projectile points recovered from excavations at 23BE337 and upon thermoluminescence dates, an upper component was delimited from a lower component at 30 cm; the upper component correlates with the Late Woodland period and the lower component roughly correlates with the Late Archaic period (Susan Goldberg, personal communication). As Table 6 reveals, differences of chert use through time in square

TABLE 5

Site 23BE337
Total Artifact Composite for Squares: 60 S 79 E, 62 S 83 E, 66 S 83 E

	Biface	Scraper Unifacial	Core Flaked	Shatter	Flake Fragment	Flake Primary	Flake Secondary	Flake Tertiary	Flake Tertiary Trim	Flake Cortex	Total No. Artifacts	Total %
Square 60 S 79 E												
Mo	-	-	-	6	21	-	-	-	-	-	27	5.0
Mk	-	-	-	6	8	-	-	-	-	-	14	2.6
Ojc	-	-	-	144	276	-	-	4	-	-	424	78.2
Indeterminate	-	-	-	66	11	-	-	-	-	-	77	14.2
Total	-	-	-	222	316	-	-	4	-	-	542	100.0
Square 62 S 83 E												
Mo	-	-	-	64	48	-	-	2	-	-	114	18.6
Mk	1	-	-	-	3	-	-	1	-	-	5	0.8
Ojc	3	-	1	225	147	5	2	14	1	-	398	64.9
Indeterminate	-	-	-	73	23	-	-	-	-	-	96	15.7
Total	4	-	1	362	221	5	2	17	1	-	613	100.0
Square 66 S 83 E												
Mo	1	-	-	11	27	-	-	-	-	-	39	10.9
Mk	1	-	-	4	3	-	-	-	-	-	8	2.2
Ojc	-	1	-	83	168	-	-	4	-	2	258	72.1
Indeterminate	-	-	-	23	30	-	-	-	-	-	53	14.8
Total	2	1	-	121	228	-	-	4	-	2	358	100.0
All Squares Combined												
Mo	1	-	-	81	96	-	-	2	-	-	180	11.9
Mk	2	-	-	10	14	-	-	1	-	-	27	1.8
Ojc	3	1	1	452	591	5	2	22	1	2	1080	71.4
Indeterminate	-	-	-	162	64	-	-	-	-	-	226	14.9
Total	6	1	1	705	765	5	2	25	1	2	1513	100.0

TABLE 6

Site 23BE337
Chi-Square Comparison of Components by Square

Square 60 S 79 E

		Chert Type					
		Mo		Mk		Ojc	
Component	Level	Tool	Debris	Tool	Debris	Tool	Debris
Upper	PZ	0	6	0	8	0	116
Upper	0-10	0	4	0	1	0	45
Upper	10-20	0	3	0	3	0	96
Upper	20-30	0	3	0	1	0	36
Lower	30-40	0	7	0	0	0	93
Lower	40-50	0	4	0	1	0	24
Lower	50-60	0	0	0	0	0	6
Lower	60-70	0	0	0	0	0	8

A. Frequencies

	Chert Type			
Component	Mo	Mk	Ojc	Total
Upper	16	13	293	322
Lower	11	1	131	143
Total	27	14	424	465

B. Chi-Square Values

	Chert Type		
Component	Mo	Mk	Ojc
Upper	- .39	+ 1.13	.00
Lower	+ .88	- 2.53	.00

Chi-Square = 4.93 df = 2 $.10 > p > .05$

TABLE 6: Continued

Site 23BE337
Chi-Square Comparison of Components by Square

Square 62 S 83 E

		Chert Type					
		Mo		Mk		Ojc	
Component	Level	Tool	Debris	Tool	Debris	Tool	Debris
Upper	PZ	0	12	1	2	0	54
Upper	0-10	0	16	0	0	0	37
Upper	10-20	0	11	0	0	0	71
Upper	20-30	0	15	0	2	1	67
Lower	30-40	0	17	0	0	0	83
Lower	40-50	0	22	0	0	0	35
Lower	50-60	0	21	0	0	3	47

A. Frequencies

	Chert Type			
Component	Mo	Mk	Ojc	Total
Upper	54	5	230	289
Lower	60	0	168	228
Total	114	5	398	517

B. Chi-Square Values

	Chert Type		
Component	Mo	Mk	Ojc
Upper	- 1.48	+ 1.75	+ .25
Lower	+ 1.88	- 2.20	- .32

Chi-Square = 7.88 df = 2 .025 > p > .01

TABLE 6: Continued

Site 23BE337
Chi-Square Comparison of Components by Square

Square 66 S 83 E

Component	Level	Mo Tool	Mo Debris	Mk Tool	Mk Debris	Ojc Tool	Ojc Debris
Upper	PZ	0	2	0	4	1	60
Upper	0-10	0	6	0	1	0	30
Upper	10-20	0	3	0	0	0	38
Upper	20-30	0	5	0	0	0	44
Lower	30-40	0	8	1	0	0	33
Lower	40-50	1	14	0	2	0	52

A. Frequencies

Component	Mo	Mk	Ojc	Total
Upper	16	5	173	194
Lower	23	3	85	111
Total	39	8	258	305

B. Chi-Square Values

Component	Mo	Mk	Ojc
Upper	- 3.13	.00	+ .26
Lower	+ 5.47	.00	- .84

Chi-Square = 9.7 df = 2 $.01 > p > .005$

60S 79E were not significant; however, temporal differences in chert use in squares 62S 83E and 66S 83E were significant. In both squares, there was less use of Mo chert in the upper component and a greater use of Mo chert in the lower component than expected. On the other hand, there was a greater use of Mk chert in the upper component of square 60S 79E and square 62S 83E and less use of Mk in the lower components than expected. Temporally, the use of Ojc chert did not vary much from the expected in any of the three squares.

Due to the low number of artifacts identified as tools (eight) from the three squares analyzed, a statistical comparison between artifact types (tool/debris) and chert types was not made. However, because debris (flakes, shatter, etc.) is a more reliable indicator of local resource exploitation and utilization than (often curated) tools (see "Local vs. Non-Local and Exotic Procurement and Depositional Patterns") and because of the much larger debris samples, a comparison was made between debris and collection predictions by square to determine possible square-specific non-random utilization patterns (Table 7). Although the chi-square values from all three square comparisons are significant at the .05 level, the results from square 66S 83E are closer to the predicted and less significant than the much larger and highly significant chi-square values of squares 60S 79E and 62S 83E. However, as Table 7 indicates, the chert utilization patterns from the latter two squares are quite different. For example, whereas in square 60S 79E the use of Mo chert was much lower than expected and the use of Ojc chert was unexpectedly greater, in square 62S 83E the use of Mo chert was greater than predicted and that of Mk chert much less than predicted. The difference between the two squares may be due to particular chert type activity areas, such as a Mo reduction station in the vicinity of square 62S 83E.

A chi-square goodness-of-fit test, which compared the predicted and observed chert-artifact frequencies for the combined three squares analyzed at 23BE337, suggests that the null hypothesis that the 23BE337 artifacts are made of chert uniformly procured from available resources be rejected. It appears (Table 8) that there was a much smaller use of Mk chert than predicted, a somewhat smaller use of Mo chert than expected, and a somewhat greater use of Ojc chert than predicted. The surprisingly low utilization of Mk chert is probably due to very poor knapping qualities (highly weathered, blocky structure, and incipient fracture planes) which were usually present in the Mk nodules in the immediate vicinity of 23BE337. The greater than expected use of Ojc chert at 23BE337 (84%) seems to indicate a strong preference for this generally finer-grained, better quality chert over the other two local but predominantly poorer quality (Mk and Mo) chert types.

TABLE 7

Site 23BE337
Comparison of Debris to Collection Predictions
By Square

Chert Type	Observed %	Predicted %	0	E	$\frac{(O-E)^2}{E}$
Square 60 S 79 E					
Mo	5.8	17	27	79.05	34.27
Mk	3.0	5	14	23.25	3.68
Ojc	91.2	78	424	362.70	10.36
Chi-Square = 48.31		df = 2	p < .001		
Square 62 S 83 E					
Mo	22.3	17	114	87.04	8.35
Mk	0.8	5	4	25.60	18.22
Ojc	76.9	78	394	399.36	.07
Chi-Square = 26.64		df = 2	p < .001		
Square 66 S 83 E					
Mo	12.6	17	38	51.34	3.47
Mk	2.3	5	7	15.10	4.34
Ojc	85.1	78	257	235.56	1.95
Chi-Square = 9.76		df = 2	.01 > p > .005		

TABLE 8

Site 23BE337
Chi-Square Analysis of Squares 60 S 79 E, 62 S 83 E,
66 S 83 E Chert-Artifacts

Chert Type	Observed %	Predicted %	O	E	$\frac{(O-E)^2}{E}$
Mo	14.0	17	180	218.79	6.88
Mk	2.1	5	27	64.35	21.68
Ojc	83.9	78	1080	1003.86	5.78

Chi-Square = 34.34 df = 2 $p < .001$

In sum, the artifactual evidence from 23BE337 does not support the economizing hypothesis that there is a direct relationship between proximity to chert resources and chert utilization. The analyses suggest that the availability-utilization model is somewhat more complex – that the quality of the particular chert resources is an important factor in utilization, in addition to distance to or availability of the chert resources. Although the data reveal the sole utilization of the locally available and abundant chert resources, they also indicate a clear preference among the three locally available chert types – especially for the usually finer-grained, better knapping quality Ojc chert. Jefferson City chert was favored six to one over the next most popular chert type, Burlington, which is locally variable in quality. It seems as though the predominantly weathered and fractured, poor quality Chouteau chert was virtually ignored at this site. It should be pointed out, however, that although statistically the observed percentages of chert-artifacts differed significantly from the predicted percentages, the overall chert exploitation pattern supported the original prediction of a predominant utilization of Ojc chert, a supplemental role for Mo chert, and minimal use of Mk chert. Temporally, it appears that there was a greater use of Mo chert during the Archaic period than during Late Woodland times.

23HI297

HI297 CHERT SURVEY (AVAILABILITY)

Territory HI297 (Fig. 9) is located in Hickory County in the northeast portion of the 15' U.S.G.S. Hermitage Quadrangle at the confluence of Mill Creek and the Pomme de Terre River. The territory is bisected east-west by the Pomme de Terre River. The southern half of HI297 is in turn bisected by Mill Creek which defines the SE and SW quadrants. The northern half of the territory, which encompasses the southern portion of Williams Bend meander loop, is bisected into NE and NW quadrants by an unnamed county road oriented north-south.

Seven chert sites were recorded within HI297. Five of these chert sites were sampled from residuum – all on the Ojc formation. The other two sites were sampled from stream deposited chert, one of which contained only Ojc nodules and one of which contained both Mo and Ojc nodules. An additional three chert sites were sampled and recorded 3 km west of HI297 – two residuum sites (one Mk and one Mo) and one *in situ* bedrock chert site (Ojc).

The Ojc formation is the only chert-bearing formation that outcrops within HI297. An isolated occurrence of a few highly weathered and basically unknappable Mo nodules was

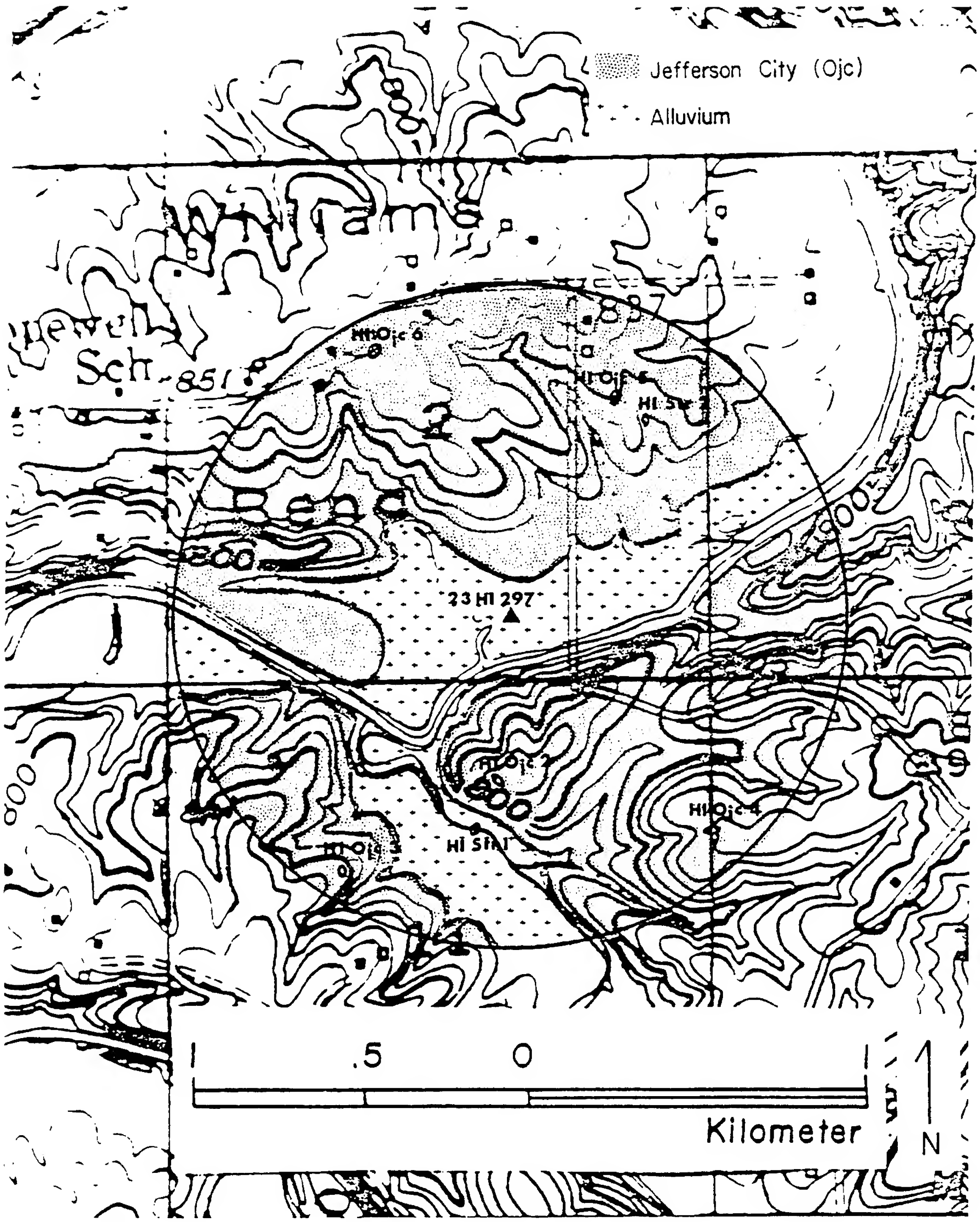

Figure 9. Chert Survey of Territory HI297.

found in a small intermittent stream in the NE quadrant. This single occurrence of Mo chert is probably due to either remnant residuum washed into the creek or is a remnant deposit of ancient terrace gravels.

Jefferson City chert outcrops as residuum from 720' (base level) to the highest points in all the quadrants (840' NE and SW; 860' NW; 890' SE). About half of the residual Ojc sites sampled exhibited a fair amount (about 20%) of good quality chert. Even on the other sites dominated by poor quality, hard quartzose Ojc, a few good quality nodules can be found if searched for in earnest. In addition, a larger percentage of good quality Ojc chert could probably be located if quarried for below the frost-line.

The one major tributary to the Pomme de Terre River within HI297, Mill Creek, was sampled at chert site HI Str 1 (Plate 5d) for type and quality of the stream bed chert. Only Ojc chert was found to be present in the extensive creek gravel after a fairly intensive survey. According to the Geologic Map of Missouri (Anderson, *et al*. 1979), the entire drainage basin of Mill Creek is on the Ojc formation; the chert sample from HI Str 1 supports this. The Ojc chert was very variable in both color and quality but it looked like a fairly good source for fist-to-head sized Ojc nodules.

Both residual and stream deposited Ojc chert is readily accessible within HI297. Although residual nodules are available on the hill slopes and ridge tops throughout the territory (but predominantly south of the Pomme de Terre River) and was probably the major chert source, redeposited stream bed chert, especially in Mill Creek, was also undoubtedly an important chert source.

According to the Geologic Map of Missouri (Anderson, *et al*. 1979), only the Ojc formation outcrops along the Pomme de Terre River valley 10 km north and 15 km south of HI297; however, the Roubidoux formation outcrops 10 km to the east of this territory in Starks Creek valley and the Mississippian formations (Mk and Mo) outcrop only 2-3 km west of HI297 along the Mississippian-Ordovician regional contact, the Eureka Springs Escarpment.

To determine the exact locations and elevations at which the Mk and Mo cherts outcrop in the latter area and their proximity to HI297, sites were sampled about 2.5 km west of this territory. At the base of the Eureka Springs Escarpment, the Ojc formation outcrops from 50' to 100' lower than within HI297 due to the regional Ozark uplift of strata east of the escarpment. An examination of formation boundaries along the Eureka Springs Escarpment determined that Ojc outcrops from base level to only 790', Mk outcrops between about 790' to 830', and Mo outcrops from around 830' to the top of the prairie plateau at 1060'.

The Mo chert sampled at HI Mo 1 was generally of poor to fair quality, but some good quality Mo (about 15% of the total residuum) was found. Most of this Mo chert sampled was subsurface residuum, recently brought to the surface by powerline construction. The Mk chert at HI Mk 1 was relatively scarce but the nodules that were found ranged from poor to good quality. Although the Mk and Mo sites sampled were 3 km from 23HI297, these formations outcrop to at least 2 km and possibly as close as 1.5 km from 23HI297. Thus, some knappable Mo and Mk cherts were available by walking about 2-3 km west of 23HI297 to the escarpment and also probably in stream gravel deposits in the Pomme de Terre River and a few of its tributaries draining from the escarpment to the west.

At chert site HI Ojc 7 at the base of the escarpment, four distinct varieties of Ojc chert were discovered in situ just below the Mk-Ojc contact (unconformity), which created a nick point 2.3 meters high. Three of the four varieties of Ojc chert were good quality material, and one variety near the top of the site was loaded with gastropods – the first fossils ever noted by the Chert Survey in any Ojc chert. Since there is enough good quality material and it is fairly easy to quarry, there is a good possibility that HI Ojc 7 was utilized as an aboriginal in situ bedrock quarry.

The percentages of expected chert frequencies in the artifact collection of 23HI297 was initially predicted to be: Ojc-97%, Mk-1%, and Mo-2%. However, after a re-evaluation of chert resources east and west of HI297, the chert percentages were revised to: 0.5% Or, 90% Ojc, 3% Mk, and 6.5% Mo.

Two archeological sites were found during the Chert Survey of HI297 and the adjacent escarpment. In the SE quadrant at chert site HI Ojc 2, nine artifacts knapped from Ojc chert were found; this archeological site was designated 23HI401. All nine Ojc artifacts were identical in appearance to the local material at HI Ojc 2, which has a fair amount of good quality Ojc chert available.

At chert site HI Mo 1 on top of the Eureka Springs Escarpment 3 km from 23HI297, a relatively large prehistoric site designated 23HI299 was discovered. Most of the artifacts were collected from the surface of this site, which had been bulldozed to clear the area of trees for a new powerline; ground cover was about 25%. A total of 288 artifacts were recovered, of which 182 (63.2%) were made from Ojc chert, 102 (35.4%) were knapped from the local Mo chert, and a mere 4 (1.4%) were made from Mk chert. Six projectile points were found on the site; three were knapped from Ojc chert and three from Mo chert. It is significant to note that over 60% of the artifacts collected were made from Ojc

chert that had to be carried at least 230' upslope to 23HI299 to be manufactured. This significance lies in the fact that 168 of the total 182 Ojc artifacts were flakes or debris and that seven more were cores. Debitage, flakes, and cores are considered accurate indicators of on-site lithic reduction. The three Ojc projectile points and four biface fragments are less accurate indicators of on-site lithic reduction since these portable tools could have been manufactured at the base of the escarpment and later carried up the slope. Evidently Ojc chert was so highly regarded by prehistoric flint workers at this site that it was well worth the effort to transport the chert from the base of the escarpment to its summit, even though good quality Mo chert was in the immediate vicinity.

23HI297 ARTIFACTUAL ANALYSIS (UTILIZATION)

Archeological site 23HI297 is a tested site at which excavation of sixteen 1 x 1 m squares yielded a total of 26,838 artifacts. Artifacts from three squares were selected for chert analysis. Square 221N 92W was excavated to a depth of 30 cm and contained 1,297 artifacts; square 221N 115W was excavated to a depth of 40 cm and yielded 685 artifacts; and square 221N 132W was excavated to a depth of 30 cm and contained 849 artifacts. The combined number of artifacts from all three squares which were chert typed for this analysis totaled 2,831 or 10.5% of the 26,838 artifacts excavated from 23HI297. The data are presented in Table 9.

Based on the observation that a midden-like feature terminated at a depth of 10 cm and based on square profiles and diagnostic projectile points recovered from the excavations, an upper component was delimited from a lower component at 10 cm (Susan Goldberg, personal communication). Three projectile points were excavated from the squares analyzed for this study. Two projectile points knapped from Ojc chert were excavated from square 221N 92W. The first projectile point found in the plow zone was classified as an indeterminant corner-notched point since only a portion of the corner-notched base was recovered. The other projectile point was located at 20 cm below the surface and was identified as an Afton point, generally considered a Late Archaic point type. One questionable projectile point made of Ojc chert was excavated from the plow zone of square 221N 132W. Although classified as a triangular point, it also resembles a retouched flake. If it is a true projectile point, it would date to the Mississippian period. As a result of a study of these and other diagnostic tools excavated from 23HI297, the upper component has been designated as Late Woodland and the lower component as Archaic (Susan Goldberg, personal communication).

TABLE 9

Site 23HI297
Total Artifact Composite for Squares 221 N 92 W, 221 N 115 W, 221 N 132 W

	Projectile Point	Biface	Scraper Unifacial	Scraper Bifacial	Core Flaked	Drill	Graver	Knife	Shatter	Flake Fragment	Flake Primary	Flake Secondary	Flake Tertiary	Flake Tertiary Bifacial Trim	Flake Tertiary Trim	Total No. Artifacts	Total %
Square 221 N 92 W																	
Mo	-	1	-	-	-	-	-	-	4	2	-	-	2	-	1	10	0.8
Mk	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	7	0.5
Ojc	2	11	1	-	6	1	-	-	497	399	3	6	84	-	79	1089	84.0
Indeterminate	-	-	-	-	-	-	-	-	119	57	-	2	9	-	4	191	14.7
Total	2	12	1	-	6	1	-	-	620	465	3	8	95	-	84	1297	100.0
Square 221 N 115 W																	
Mo	-	1	-	-	-	-	-	-	2	23	-	1	3	-	-	30	4.4
Mk	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.1
Ojc	-	3	13	1	2	-	3	1	96	370	3	9	15	7	1	524	76.5
Indeterminate Mississippian	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	2	0.3
Indeterminate	-	-	3	-	-	-	-	-	71	45	2	3	2	2	-	128	18.7
Total	-	4	16	1	2	-	3	1	170	439	5	13	21	9	1	685	100.0
Square 221 N 132 W																	
Mo	-	2	-	1	-	-	-	-	9	24	-	-	8	-	9	53	6.3
Mk	-	2	-	-	-	-	-	-	-	1	-	-	-	-	-	3	0.4
Ojc	1	6	7	-	11	-	-	-	248	191	1	11	89	-	72	637	75.0
Og	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	2	0.2
Indeterminate Mississippian	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.1
Indeterminate	-	1	1	-	-	-	-	-	81	45	-	4	14	-	7	153	18.0
Total	1	11	8	1	12	-	-	-	339	261	1	15	111	-	89	849	100.0
All Squares Combined																	
Mo	-	4	-	1	-	-	-	-	15	49	-	1	13	-	10	93	3.29
Mk	-	2	-	-	-	-	-	-	-	9	-	-	-	-	-	11	0.39
Ojc	3	20	21	1	19	1	3	1	841	960	7	26	188	7	152	2250	79.48
Og	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	2	0.07
Indeterminate Mississippian	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1	3	0.10
Indeterminate	-	1	4	-	-	-	-	-	271	147	2	9	25	2	11	472	16.67
Total	3	27	25	2	20	1	3	1	1129	1165	9	36	227	9	174	2831	100.00

In an effort to determine whether there was a significant difference in chert utilization temporally at 23HI297, a chi-square comparison of chert use in the upper and lower components was made for each square. As Table 10 reveals, chert use did not vary significantly between components in squares 221N 115W and 221N 132W. The chi-square value of square 221N 92W was nearly significant. There was some, although limited, use of Mo and Mk cherts in the lower component but very little or no use of Mo and Mk cherts in the upper component. In other words, the use of Mo and Mk chert types possibly decreased slightly through time (Archaic to Woodland) in the vicinity of square 221N 92W, but the observed differences may be due to chance.

Chi-square tests were made to determine whether artifact types (tool/debris) were nonrandomly distributed within chert types in any of the three squares. The results in Table 11 indicate that at the .05 level of probability artifact types are randomly distributed within chert types in square 221N 92W and square 221N 115W but nonrandomly distributed in square 221N 132W. The single cell with a large chi-square value is the Mk tool cell. This may be due to selection of Mk chert for certain types of tools — in this case both Mk tools were bifaces.

Since debris (flakes, shatter, etc.) is a more reliable indicator of local resource exploitation and utilization than tools (see "Local vs. Non-Local and Exotic Procurement and Depositional Patterns") and because of the much larger debris samples, a comparison was made between debris and collection predictions by square to determine possible square-specific non-random utilization patterns. Although all comparisons produced chi-square values with probabilities of less than .001, the chi-square value for square 221N 92W was much higher than the other two squares. As Table 12 indicates, this appears to be the result of much different utilization patterns of chert at square 221N 92W than at 221N 115W or 221N 132W. Whereas in the latter two squares the large chi-square values are due to a lower utilization of Mk chert than expected, in square 221N 92W the high chi-square value is due to a much lower utilization of Mo chert than expected and a greater utilization of Ojc than predicted in addition to a low utilization of Mk chert. The difference between the squares may be due to particular chert type activity areas. Spatially, there appears to be a greater use of Mo chert as one moves westward across the site. For example, at square 221N 92W, Mo makes up less than one percent of the identifiable chert-artifacts recovered, whereas twenty-three meters west Mo comprises 5.5% of the identifiable chert-artifacts collected, and seventeen meters further west at square 221N 132W Mo comprises 7.5% of the identifiable chert-artifacts recovered.

TABLE 10

Site 23HI297
Chi-Square Comparison of Components by Square

Square 221 N 92 W

Component	Level	Mo Tool	Mo Debris	Mk Tool	Mk Debris	Ojc Tool	Ojc Debris
Upper	PZ	0	0	0	0	5	35
Upper	0-10	0	0	0	0	2	219
Lower	10-20	1	6	0	4	7	399
Lower	20-30	0	3	0	3	7	415

A. Frequencies

Component	Mo	Chert Type Mk	Ojc	Total
Upper	0	0	261	261
Lower	10	7	828	845
Total	10	7	1089	1106

B. Chi-Square Values

Component	Mo	Chert Type Mk	Ojc
Upper	- 2.36	- 1.65	+ .06
Lower	+ .73	+ .51	- .02

Chi-Square = 5.33 df = 2 $.10 > p > .05$

TABLE 10: Continued

Site 23HI297
Chi-Square Comparison of Components by Square

Square 221 N 115 W

		Chert Type					
		Mo		Mk		Ojc	
Component	Level	Tool	Debris	Tool	Debris	Tool	Debris
Upper	PZ	0	4	0	0	5	35
Upper	0-10	0	6	0	0	14	197
Lower	10-20	1	6	0	0	4	178
Lower	30-40	0	13	0	1	0	91

A. Frequencies

	Chert Type			
Component	Mo	Mk	Ojc	Total
Upper	10	0	251	261
Lower	20	1	273	294
Total	30	1	524	555

B. Chi-Square Values

	Chert Type		
Component	Mo	Mk	Ojc
Upper	- 1.19	- .47	+ .08
Lower	+ 1.06	+ .42	.00

Chi-Square = 3.22 df = 2 .25 > p > .10

TABLE 10: Continued

Site 23HI297
Chi-Square Comparison of Components by Square

Square 221 N 132 W

Component	Level	Mo Tool	Mo Debris	Mk Tool	Mk Debris	Ojc Tool	Ojc Debris
		Chert Type					
Upper	PZ	1	4	1	0	11	36
Upper	0-10	1	26	0	1	10	377
Lower	10-20	0	12	0	0	2	142
Lower	20-30	1	8	1	0	2	57

A. Frequencies

Component	Chert Type Mo	Mk	Ojc	Total
Upper	32	2	434	468
Lower	21	1	203	225
Total	53	3	637	693

B. Chi-Square Values

Component	Chert Type Mo	Mk	Ojc
Upper	- .40	.00	+ .03
Lower	+ .83	.00	- .07

Chi-Square = 1.33 df = 2 .75 > p > .50

TABLE 11

Site 23HI297
Chi-Square Comparison of Tools to Debris by Square

Artifact Type	Mo	Chert Type Mk	Ojc	Total
Square 221 N 92 W				
A. Frequencies				
Tools	1	0	21	22
Debris	9	7	1068	1084
Total	10	7	1089	1106
B. Chi-Square Values				
Tools	+3.20	-.14	-.02	
Debris	- .07	.00	.00	
Chi-Square = 3.43	df = 2	.25 > p >.10		
Square 221 N 115 W				
A. Frequencies				
Tools	1	0	23	24
Debris	29	1	501	531
Total	30	1	524	555
B. Chi-Square Values				
Tools	-.07	-.04	+.01	
Debris	.00	.00	.00	
Chi-Square = .12	df = 2	.95 > p > .90		

TABLE 11: Continued

Site 23HI297
Chi-Square Comparison of Tools to Debris by Square

Artifact Type	Mo	Chert Type Mk	Ojc	Total
<u>Square 221 N 132 W</u>				
A. Frequencies				
Tools	3	2	25	30
Debris	50	1	612	663
Total	53	3	637	693
B. Chi-Square Values				
Tools	+.22	+26.90	-.23	
Debris	-.01	+ 1.47	+.01	

Chi-Square = 28.84 df = 2 p < .001

TABLE 12

Site 23HI297
Comparison of Debris to Collection Predictions by Square

Chert Type	Observed %	Predicted %	O	E	$\frac{(O-E)^2}{E}$
Square 221 N 92 W:					
Mo	0.8	6.5	9	70.46	53.61
Mk	0.7	3.0	7	32.52	20.03
Ojc	98.5	90.0	1068	975.60	8.75
Or	0.0	0.5	0	5.42	5.42
Chi-Square = 87.81		df = 3	p < .001		
Square 221 N 115 W:					
Mo	5.5	6.5	29	34.52	.88
Mk	0.2	3.0	1	15.93	13.99
Ojc	94.3	90.0	501	477.90	1.12
Or	0.0	0.5	0	2.66	2.66
Chi-Square = 18.65		df = 3	p < .001		
Square 221 N 132 W:					
Mo	7.5	6.5	50	43.10	1.11
Mk	0.2	3.0	1	19.89	17.94
Ojc	92.3	90.0	612	596.70	.39
Or	0.0	0.5	0	3.32	3.32
Chi-Square = 22.76		df = 3	p < .001		

A chi-square goodness-of-fit test, which compared the predicted and observed chert-artifact frequencies for the combined three squares analyzed at 23HI297, suggests that the null hypothesis that the artifacts at 23HI297 were made of chert in proportion to its availability be rejected. As Table 13 indicates, it appears that there was a much smaller use of Mk chert than expected and a smaller use of Mo chert than predicted, but a greater use of Ojc chert than expected. This discrepancy is probably due to a strong preference for the closer and generally finer-grained, better quality Ojc chert. In fact, the utilization of chert resources in all three test squares was almost exclusively in favor of Ojc. For example, of the 2,359 artifacts identified as to a particular chert type, 2,250 of them or 95.4% were manufactured from Ojc chert – only 109 artifacts or 4.6% were determined to be made from a chert other than Ojc. Of these 109 artifacts, ninety-three or 3.9% were manufactured from Mo chert and eleven or 0.5% were made from Mk chert. A non-local Ordovician chert type was represented in the artifact sample from 23HI297 by two artifacts (0.1%), however, the chert type was identified as Gasconade (Og) instead of the predicted Roubidoux (Or). Three pieces (0.1%) of an unidentified Mississippian chert were also present as well as 472 pieces of totally unidentifiable or indeterminant chert. The disparity between the predicted and observed chert-artifact frequencies for 23HI297 may also be due in part to an overestimation of the nearby (2 km distant) Mo and Mk resources.

In sum, the chert type analysis of the sample (10.5%) of artifacts from 23HI297 does not support the null hypothesis of proportional use of chert resources. The analyses suggest that quality is again an important factor in chert utilization as well as proximity of available resources, thus, probably creating the greater than expected use of Ojc chert because of a preference or selectivity for this fine-grained chert with good knapping qualities. Although Mo and Mk chert resources are available as close as 2 km west of 23HI297 along the Eureka Springs Escarpment, they were essentially ignored for flint knapping purposes. It should be pointed out that although statistically the observed percentages of chert-artifacts differed significantly from the predicted percentages, the overall chert exploitation pattern supported the Chert Survey prediction of an overwhelming utilization of Ojc chert and minimal use of Mo and Mk chert types. Analyses also indicate that although the utilization of Mo and Mk cherts was generally less than expected, the use of Mo chert was still at least twice as great as that of Mk chert as predicted. Spatially, it appears there was a greater utilization of Mo chert on the western portion of the site than on the eastern portion. Temporally, differential chert utilization between the two identified components was basically insignificant. In spite of the above utilization patterns, the two Og chert-artifacts and the

TABLE 13

Site 23HI297
Chi-Square Analysis of Squares 221 N 92 W,
221 N 115 W, and 221 N 132 W Chert-Artifacts

Chert Type	Observed %	Predicted %	O	E	$\frac{(O-E)^2}{E}$
Mo	3.9	6.5	93	153.01	23.54
Mk	0.5	3.0	11	70.62	50.33
Ojc	95.6	90.0	2250	2118.60	8.15
Or	0.0	0.5	0	11.77	11.77

Chi-Square = 93.79 df = 3 $p < .001$

three indeterminant Mississippian chert pieces probably indicate some mode of procurement and transportation of at least a very small amount of non-local or exotic cherts.

23SR189

SR189 CHERT SURVEY (AVAILABILITY)

Territory SR189 (Fig. 10) is located in St. Clair County in the west-central portion of the Valhalla Quadrangle at the confluence of Butler Hollow Branch and the Osage River and just east of Ninnescah Park. SR189 is bisected east-west by the Osage River and the northern half of the territory is bisected by Butler Hollow which defines the NE and NW quadrants. The SE quadrant is composed of a steep cut bank and flat upland trending northeast-southwest. The SW quadrant consists mostly of flat bottomland.

Fourteen chert sites were recorded within SR189. Eight of these sites were sampled from residuum deposits (3 Mk and 5 Mo), two sites were sampled from *in situ* Mk limestone exposed in cut banks, and four sites were sampled from stream deposits.

In the NE and SE quadrants, localized Pennsylvanian sandstone boulders cap the Mo limestone on the ridge tops as residuum. The Mo limestone, which is coarse-grained, usually begins outcropping at about 750' and continues up to the top of the ridges at 861' and 768' respectively. The Mo chert is usually poor quality for knapping purposes because it is highly weathered. The poor quality may be due to the fact that the Mo chert within SR189 is very fossiliferous and porous which might have contributed to its apparently accelerated weathering.

The Mo-Mk contact varies between 745' and 755' AMSL. The Mk limestone, which is usually medium to fine-grained, was found to outcrop from about 750' down to the summer 1979 pool level of about 693'. The quality of the Mk chert varies from very fractured and weathered to very good knappable chert, but the good quality material usually makes up only about 10% of the total Mk chert present. Still, throughout the 1979 Chert Survey, SR189 was one of only two territories in which Mk chert of good quality was found in relatively significant quantity.

According to the land surveyable, the Ojc formation does not outcrop within SR189 – at least not above 693' which was the pool level on the Osage River in mid-July 1979 at the time of the Chert Survey. Nevertheless, there is a good possibility that the Ojc stratum does outcrop below 693' because the Mk formation, which outcrops between 693' to about 750' in SR189, rarely exceeds 50-60' in thickness

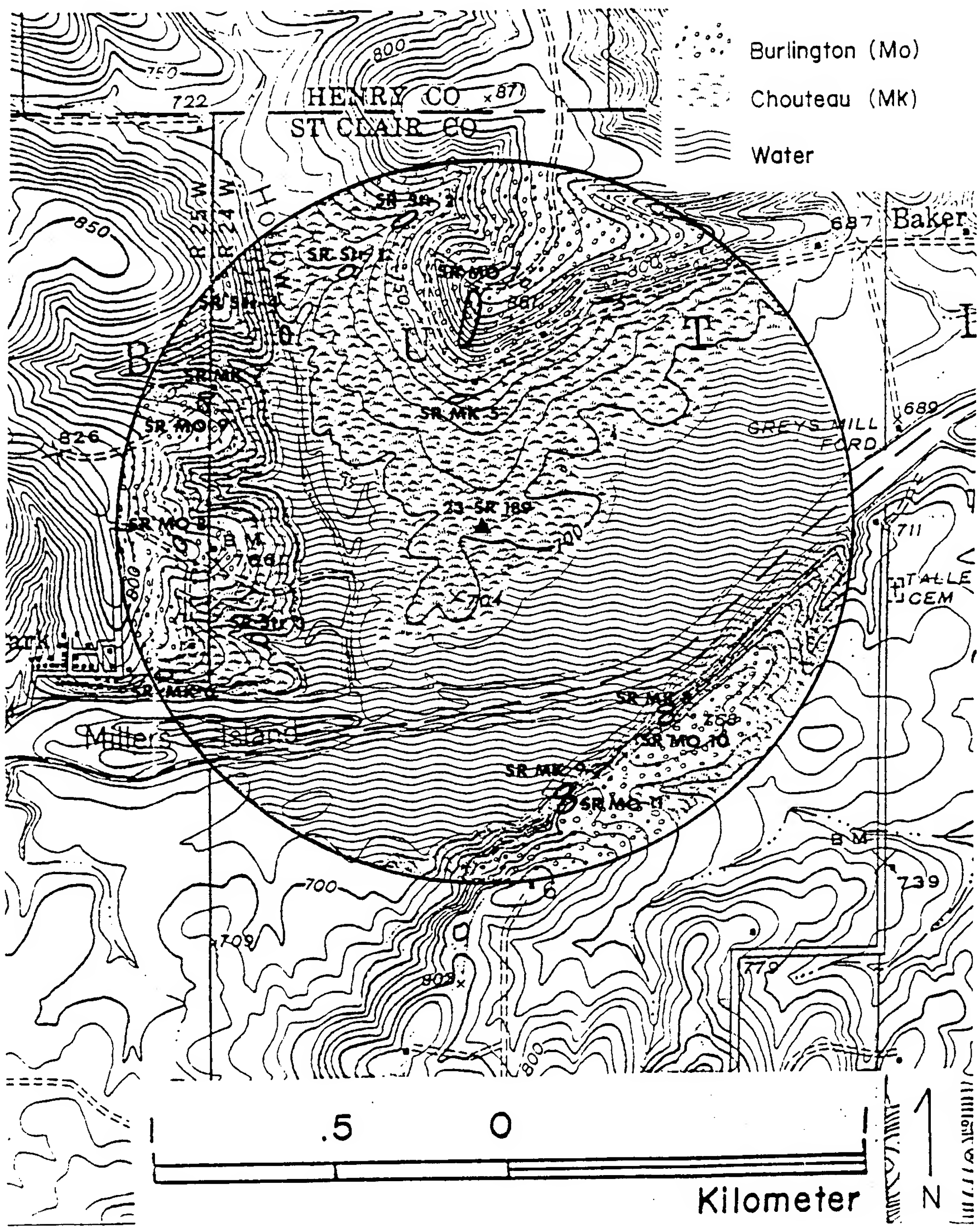

Figure 10. Chert Survey of Territory SR189.

in the Truman Reservoir area. Therefore, the 23' of stratum unaccounted for between 670' (base level) and 693' is probably at least partly Ojc. According to the <u>Geologic Map of Missouri</u> (Anderson, <u>et al</u>. 1979), the closest that Ojc outcrops to <u>SR189</u> is 2 km east and west of the territory on the north side of the river. Surprisingly though, at SR Str 4, four chunks of Ojc chert were found in the creek gravel. This occurrence of Ojc must be due to either an anomalous localized uparched outcrop or fault system upstream on Butler Hollow Branch outside the territory.

The Chert Survey of resources within <u>SR189</u> indicates that subsurface residuum, stream deposited chert, and bedrock chert sources were probably all utilized to a large degree by local prehistoric inhabitants.

The artifactual chert percentages for 23SR189 were originally predicted to be: 2% Ojc, 83% Mk, and 15% Mo. However, after reconsidering the strong possibility that Ojc chert exists between 670' and 690', its relatively close outcroppings 2 km east and west of the territory, and its availability in Butler Hollow Branch and Osage River gravels, and the fact that better quality Mo chert exists below the frost-line, the chert percentage predictions were revised to: 20% Ojc, 60% Mk, and 20% Mo.

One previously recorded archeological site (23SR187) was resurveyed and one new archeological site (23SR778) was found during the Chert Survey of <u>SR189</u>. At 23SR187 just northeast of chert site SR Mk 6, nineteen Mk artifacts and twelve Ojc artifacts were recovered; this was the first site to be found during the Chert Survey in which Mk artifacts outnumbered Ojc artifacts.

However, in a couple of areas south of the Osage River on top of a high cut bank the story was quite different. At 23SR778, twenty-nine Ojc artifacts and one Mk flake were found. An adjacent soybean field east of 23SR778 was briefly surveyed but artifacts were not collected; the rather dense lithic scatter was estimated to consist of about 85-90% Ojc artifacts, 10-15% Mk artifacts, and 0% Mo artifacts. Most of the Ojc artifacts examined were oolitic, possibly due to the exposure of mostly upper Ojc strata in this particular portion of the reservoir. Although Ojc was not found to outcrop in <u>SR189</u>, the chert was often favored for flint working — even on top of a high cut bank 100' above the floodplain and any possible source of Ojc chert.

23SR189 ARTIFACTUAL ANALYSIS (UTILIZATION)

Archeological site 23SR189 is a tested site at which three 1 x 1 m test squares yielded a total of 6,064 artifacts. One of these three squares, 20S 85E, was selected

for chert analysis. This square, which was excavated to a depth of 81 cm, contained 844 specimens or 14% of the 6,064 total number of excavated artifacts.

Only three artifacts were identified as tools — two bifaces and one unifacial scraper. The remaining 841 artifacts were classified as debris. The total artifact composite (Table 14) for square 20S 85E reveals that the majority of Ojc chert-artifacts (65.5%) outnumber Mk chert-artifacts (20.4%) by more than 3 to 1 and Mo chert-artifacts (5.2%) by 13 to 1. The unidentifiable indeterminant chert makes up a rather small 8.7%. Interestingly, two flakes (one secondary and one tertiary) were unidentified exotic cherts to the Truman Reservoir area. The secondary flake is a greenish-grey chert with a reddish tint that contains no identifiable fossils. The tertiary flake, on the other hand, is a grey speckled white chert compacted with small, spherical and elongated unidentified fossils. This chert flake bears a slight resemblance to the Pennsylvanian Westerville chert from the Kansas City Group and in some respects to Warsaw chert.

It should be noted that three polished flakes were discovered in the first three levels of this square; one was classified as shatter and the other two as flake fragments. These polished flakes were probably detached from either hoes or chipped stone celts. The use of heat treatment on artifacts and the utilization of some riverine chert were apparent in the sample of artifacts from 23SR189 but they were not quantified.

Although diagnostic artifacts collected from the surface of the site are representative of the Dalton through Late Woodland periods (Susan Goldberg, personal communication), there was only one projectile point fragment excavated from 23SR189 and it was unidentifiable. Thus, there was no cultural determination or temporal control for the excavated material on any level in any square. Because no components were discernible from the excavated material, a test of variability in chert utilization over time was impossible. In addition, since only three artifacts were identified as tools from square 20S 85E, no statistical test was conducted to determine whether artifact types (tool/debris) were nonrandomly distributed within chert types. However, a statistical comparison between the expected and observed chert-artifact percentages from square 20S 85E (Table 15) reveals that the probability of the cherts having been used proportionately to their availability is less than .001. The observed percentages of chert-artifacts are quite different from the predicted percentages based on chert resources surveyable within SR189. It appears that Mk and Mo chert types were utilized much less than expected and that Ojc chert was utilized much more than expected. In other words, the

TABLE 14

Site 23SR189
Total Artifact Composite for Square 20 S 85 E

	Biface	Scraper Unifacial	Shatter	Flake Fragment	Flake Primary	Flake Secondary	Flake Tertiary	Flake Tertiary Bifacial Trim	Flake Tertiary Trim	Total No. Artifacts	Total %
Mo	1	-	13	29	-	-	1	-	-	44	5.2
Mk	-	1	32	129	1	-	5	1	3	172	20.4
Ojc	1	-	68	463	-	1	17	-	3	553	65.5
Indeterminate	-	-	40	33	-	-	-	-	-	73	8.7
Exotic	-	-	-	-	-	1	1	-	-	2	0.2
Total	2	1	153	654	1	2	24	1	6	844	100.0

TABLE 15

Site 23SR189
Chi-Square Analysis of Square 20 S 85 E Chert-Artifacts

Chert Type	Observed %	Predicted %	O	E	$\frac{(O-E)^2}{E}$
Mo	5.7	20	44	153.8	78.39
Mk	22.4	60	172	461.4	181.52
Ojc	71.9	20	553	153.8	1036.16

Chi-Square = 1296.07 df = 2 $p < .001$

utilization of chert resources in the vicinity of square 20S 85E was predominantly in favor of Ojc chert instead of Mk chert as predicted – in fact, more than three times as much. This is most likely due to a much greater aboriginal preference or selection for Ojc chert than anticipated, probably because of its generally superior knapping quality as was demonstrated repeatedly by the Chert Survey at most other locations in the Truman Reservoir area. The great disparity between the predicted and observed Ojc chert-artifact percentages may also be partially due to the estimation of available Ojc resources within SR189 (because of the high pool level of the reservoir at the time of survey), rather than first-hand observation of the local Ojc chert.

Whatever the case, it is evident from the artifacts analyzed that Ojc chert was predominantly favored for most of the flint working at 23SR189, being supplemented by Mk chert, rather than vice versa. Burlington chert was evidently only rarely utilized, probably due to its highly weathered, usually poor quality in this area. Thus, the data from square 20S 85E do not support the economizing hypothesis of a direct relationship between availability of chert resources and chert use. Instead, the data suggest that quality may be a considerably more important factor in chert use, creating a preference or selection for the usually better knapping quality Ojc chert. The two unidentified exotic chert-artifacts probably indicate some procurement and transportation of exotic materials by nomadic groups or by other means such as down-the-line exchange.

23HE9

HE9 CHERT SURVEY (AVAILABILITY)

Territory HE9 (Fig. 11) is located in Henry County in the west-central portion of the Gaines Quadrangle at the confluence of Sparrow Foot Creek and the South Grand River. The territory is bisected north-south by the South Grand River. The eastern half of the territory is also bisected by the St. Louis-San Francisco Railroad which defines the NE quadrant north and east of the railroad and the SE quadrant south of the railroad. The surveyable portion of the western half of the territory was designated the SW quadrant since the NW portion of the semicircle consisted only of a broad flat floodplain.

Only three chert sites were sampled and recorded within HE9 because of limited outcrops of chert-bearing strata, due to dominating Pennsylvanian formations (Pck) in the NE and SE quadrants and low local relief in the SW quadrant. Most of the SW quadrant, in which the Mo formation did appear to surface, is mantled by a thick level layer of soil, which buries most bedrock and residuum deposits. All three

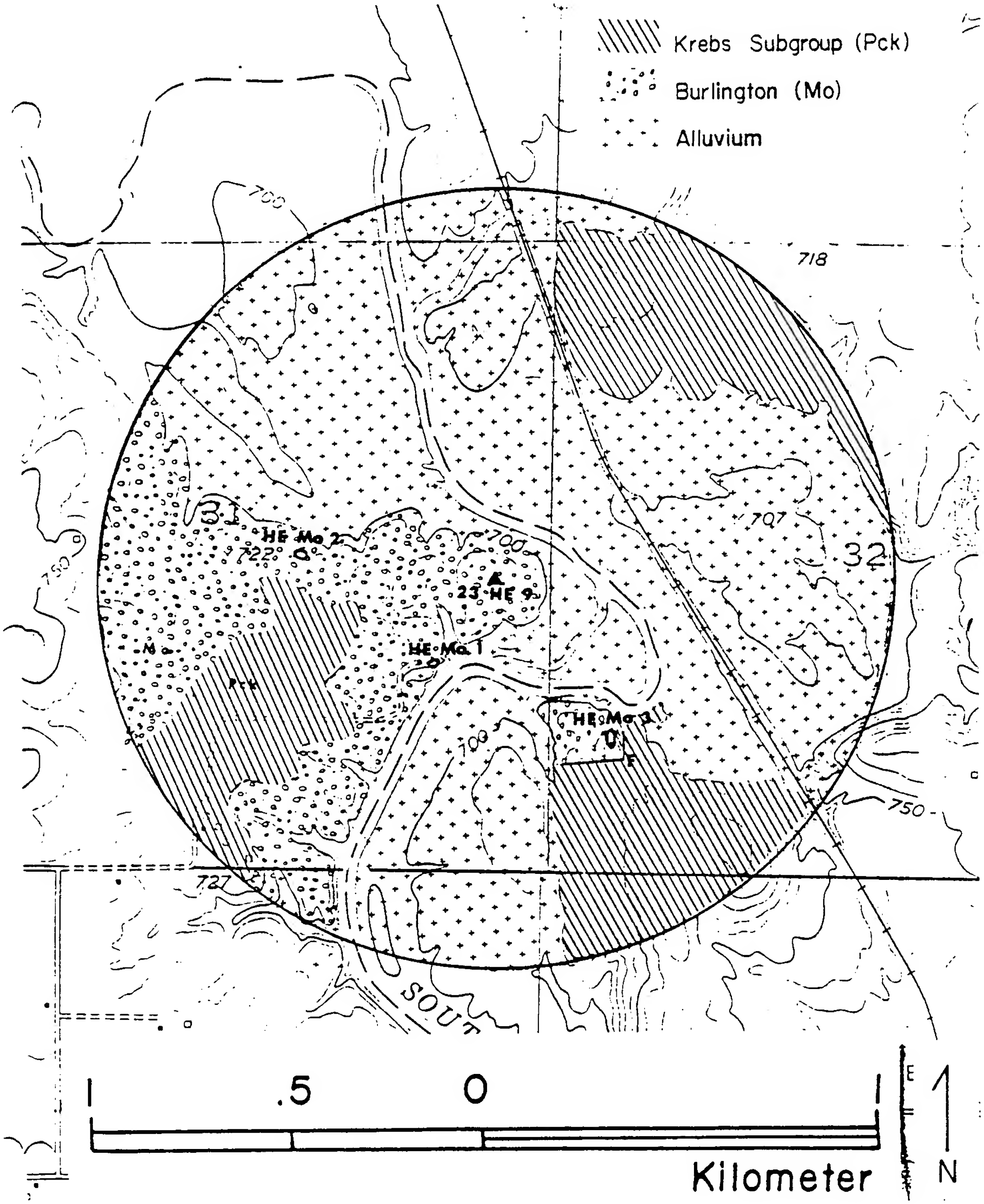

Figure 11. Chert Survey of Territory HE9.

chert sites were sampled from the Mo formation which contains the only chert-bearing strata outcropping in the territory.

The Pck Pennsylvanian formations and the Mississippian Mo limestone are the only formations that lie within the territory. Although HE9 is located on the edge of a small localized Mo outcrop area and a few similar isolated outcrop areas (outliers) of Mo limestone are situated around the territory, substantial areas of the Mo formation are exposed 2-3 km southeast in the South Grand River valley. According to the 1979 Geologic Map of Missouri (Anderson, et al. 1979), the nearest Ojc and Mk outcroppings to HE9 are approximately 12-15 km east and southeast along the South Grand and Osage Rivers, and a very small localized area on Cooper Creek 10 km due southwest. All of these Ojc and Mk chert sources are downstream from HE9 and are therefore unavailable locally even in stream bed deposits.

After surveying most of the SW quadrant, it was determined that Mo limestone underlies a shallow Pck caprock. Burlington chert was found and sampled, however, at two locations. Chert site HE Mo 1 was at the top of an active historic limestone (Mo) quarry. There was relatively little chert in the Mo formation at this locality except for the upper strata. The low percentage of inclusive chert was probably an important factor in choosing this location for a deep-mine limestone quarry. Some residual Mo chert nodules were located at chert site HE Mo 2 between about 710'-720'. The chert varied in color and in quality from poor highly weathered material to a small percent (approximately 5-10%) of fairly good nodules. An intermittant stream bed was checked for chert but only sandstone and shale were found. It is estimated that the Mo formation outcrops from 690' (base level) to 725' and is capped by as much as 15' of Pck strata.

In the SE quadrant, the third chert site (HE Mo 3) was sampled in a small localized area probably created by a fault (Fig. 11). This area was the only place in the SE quadrant where Mo was found to outcrop at the surface. This phenomenon may be due to both faulting and dipping strata since Pck sandstone was dipping to the southeast at about a 2^{o} angle a few meters from HE Mo 3. The Mo formation outcrops from 690' to 730' in this quadrant. The Pck strata, however, outcrop from 690' or 730' up to 810' in elevation. At HE Mo 3 both natural undisturbed Mo residuum and disturbed (bulldozed) subsurface residuum were sampled. There was a remarkable difference in the quality of the Mo chert in the two samples. The disturbed, up-rooted residual nodules exhibited some fine-grained good to excellent chert, whereas the undisturbed surface residuum exhibited mostly coarse-grained and highly weathered poor quality chert. These differential qualities would suggest that prehistoric flint

knappers probably quarried below the frost-line to procure good quality Mo chert. Subsurface residuum was probably the major chert source exploited in HE9.

The base of the knob in the NE quadrant was surveyed for signs of the Mo formation but no Mississippian residuum or bedrock outcrops were located because of gentle slopes and masking colluvium. Only Pennsylvanian sandstone blocks were found.

The Pck Pennsylvanian strata which outcrop in much of HE9 was found to be devoid of chert, containing principally sandstone, silt stone, shale, chertless limestone, and coal beds. The predominant sandstone member is brown to dark reddish-brown and often has a high iron content.

Based on the chert resources locally available and on the economizing hypothesis in regard to the utilization of those resources, the percentage prediction of chert frequencies to be found in 23HE9 artifacts was 100% Mo.

Two archeological sites were revisited and resurveyed during the chert reconnaissance of HE9. The first, 23HE9, was briefly revisited to determine what types of chert were present in the debitage – i.e., to evaluate whether there were any non-local Ojc and Mk pieces, exotics, etc. A small sample of 68 artifacts was collected. Somewhat surprisingly, twelve Ojc artifacts (17.7% of the total) and six Mk artifacts (8.8%) were found, although the bulk of the sample consisted of fifty Mo artifacts (73.5%). Nevertheless, 26.5% of the collected artifacts were made from non-local Ojc and Mk cherts that had to be transported to the site from downstream sources. One of the Ojc artifacts was the base of a projectile point.

The other archeological site resurveyed, 23HE251, was located within chert site HE Mo 3. At this site, all surface artifacts were collected, of which there was a total of twenty-two. Six or 27.3% of the artifacts were made from Ojc chert and sixteen or 72.7% were made from local Mo chert.

About four Ojc and fifteen Mo flakes were noted as an isolated find in a dirt road south of 23HE251 and chert site HE Mo 3.

Most of the Mo artifacts collected and examined during the survey were made from good quality Mo chert much like the disturbed residual nodules sampled at HE Mo 3. However, a few artifacts exhibited a red speckled appearance, a probable variety of Mo chert (or possibly Warsaw chert) that was not found during the Chert Survey. As exemplified by the artifacts collected and noted in HE9, Burlington (Mo) artifacts were by far dominant, indicating a preference for

exploiting the local Mo as the major chert resource. However, significant numbers of non-local Ojc and Mk cherts were also present, indicating transportation of these chert resources upstream by either direct procurement expeditions, down-the-line exchange of raw and/or modified lithic material, or via seasonal or periodic movements and wide-range wanderings.

23HE9 ARTIFACTUAL ANALYSIS (UTILIZATION)

Archeological site 23HE9 is a surface site, which means all of the artifacts collected were obtained from the surface of the ground with no temporal or spatial control due to natural and/or cultural (agricultural) disturbance processes. A total of 1041 artifacts were recovered from the surface of 23HE9 by two separate surveys – all were analyzed by chert type. Ninety-four artifacts were identified as tools; the remaining 947 artifacts were classified as debris. All are presented in Table 16 according to chert and artifact type.

The artifactual data from 23HE9 reveal the predominant utilization of the locally available Mo chert – 86.6% of all the artifacts collected from the site. However, non-local Ojc and Mk cherts, located about 10-15 km from the territory, are represented in the collections. The favored non-local chert was Ojc which made up 10.5% of the total number of artifacts. Chouteau chert was less popular, represented by only 26 artifacts or 2.5% of the artifacts.

Four exotic chert-artifacts were included in the collections. The chert of three of these artifacts was identified as Winterset, a fossiliferous dark grey Pennsylvanian chert derived from the Kansas City Group of formations located far to the northwest of the Truman Reservoir area (see Reid 1980 for a good physical description of Winterset chert). The Kansas City Group outcrop along a broad belt which underlies the Kansas City area and extends northeastward across western and northwestern Missouri (Howe 1961: 95). According to the _Geologic Map of Missouri_ (Anderson, _et al_. 1979), the closest sources of Winterset chert are outliers of the Kansas City Group 60-70 km northwest of 23HE9. However, the South Grand River rises on the Kansas City Group and thus some Winterset chert could occur as redeposited gravel within _HE9_, but the long abrasive journey downstream should render the chert unknappable. The chert of the fourth exotic was unidentified but it too is probably a Pennsylvanian chert; it is grey and contains abundant white spicules. Interestingly, three of the four exotic specimens were projectile points, probably the most mobile of prehistoric chipped-stone artifacts. One Winterset piece was a flake fragment. The two Winterset side-notched projectile points, which appear to have been heat treated, probably date to the Early to Middle Archaic period (Roper, personal

TABLE 16

Total Artifact Composite for 23HE9

	Projectile Point	Biface	Scraper Unifacial	Scraper Bifacial	Core Flaked	Denticulate	Cleaver	Shatter	Flake Fragment	Flake Primary	Flake Secondary	Flake Tertiary	Flake Tertiary Bifacial Trim	Flake Tertiary Trim	Raw Material	Total No. Artifacts	Total %
Mo	3	19	33	3	2	2	1	345	405	8	19	50	7	5	-	902	86.6
Mk	3	2	1	-	-	-	-	2	9	-	-	9	-	-	-	26	2.5
Ojc	6	10	5	-	1	-	-	18	51	-	1	13	2	1	1	109	10.5
Winterset	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	3	0.3
Exotic	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.1
Total	15	31	39	3	3	2	1	365	466	8	20	72	9	6	1	1041	100.0

communication). The unidentified exotic projectile point is probably also Early to Middle Archaic.

The deviation from the predicted exclusive use of Mo chert, i.e., the utilization of non-local Ojc and Mk and exotic chert types, is clearly due to some form of cultural activity. These non-local and exotic cherts may have been procured by direct procurement expeditions, seasonal or periodic movements in the region, or through trade networks. Although it was suspected that some non-local chert-artifacts might occur in the artifact collection, the 100% Mo utilization prediction was made to test the proposed economizing hypothesis, according to which there should have been a total utilization of the locally available Mo chert resources. The fact that 13% of the artifacts were manufactured from two non-local chert types refutes a strict interpretation of the hypothesis or exclusively local utilization. Among the non-local cherts, the obvious preference for Ojc is probably due to its generally superior knapping quality as demonstrated by sample testing throughout the reservoir area during the Chert Survey.

A chi-square test was conducted to determine whether artifact types (tool/debris) were nonrandomly distributed among chert types. The results in Table 17 indicate that at the .05 level of probability, artifact types are nonrandomly distributed among chert types and that the cells most responsible for the large chi-square value are tool cells – especially non-local Mk and Ojc tool cells. These results and the data in Table 18 indicate that a higher percentage of non-local and exotic cherts occur in tools than in debris, which agrees with the expected patterns of deposition of non-local and exotic chert-artifacts proposed earlier (see "Local vs. Non-Local and Exotic Procurement and Depositional Patterns"). For example, whereas a combination of all non-local and exotic cherts make up only 11.4% of the debris at 23HE9, they comprise 33% or three times as much of the total number of tools. In fact, 12 of the 15 projectile points found at 23HE9 were made from either non-local or exotic cherts, and one-half of these were knapped from Ojc chert. In contrast, regarding easily made and probably less frequently curated tools, 85.7% of the scrapers found at 23HE9 were made from local medium to coarse-grained Mo chert.

The debris or flakes classifiable according to stages of technological manufacture (excluding shatter and flake fragments) also support the above depositional predictions. For example, there were 16 tertiary flakes, one secondary flake, and no primary flakes identified from the Ojc debris; all of the classifiable Mk debris was tertiary flakes; and although the majority of the Mo debris was tertiary flakes, there were eight primary flakes identified.

TABLE 17

Chi-Square of Tools and Debris Chert Types at 23HE9

A. FREQUENCIES

Artifact Type	Chert Type Mo	Mk	Ojc	Total
Tools	63	6	22	91
Debris	839	20	87	946
Total	902	26	109	1,037

B. CHI-SQUARE VALUES

Artifact Type	Chert Type Mo	Mk	Ojc
Tools	− 3.29	+ 6.07	+ 16.19
Debris	+ .32	− .58	− 1.55

Chi-square = 28   df = 2 $p < .001$

TABLE 18

Observed Percentages of Tools and Debris by Chert Type and Predicted Percentages for 23HE9

Chert Type	Observed % of Tools	Observed % of Debris	Predicted %
Mo	67.0	88.6	100
Mk	6.4	2.1	0
Ojc	23.4	9.2	0
Winterset	2.1	0.1	0
Exotic	1.1	0.0	0

In regard to cultural affiliation at 23HE9, only two of the 15 projectile points were definitely identifiable to a specific projectile point type. One Ojc and one Mk projectile point were identified as Graham Cave-Big Sandy points, which date from Early to Middle Archaic (Roper, personal communication).

In sum, the artifactual evidence indicates predominant utilization of the locally available Mo chert at 23HE9 but not to the exclusion of other chert resources. Considerable numbers of non-local Ojc and Mk chert-artifacts and some exotics were also represented in certain tool and debris categories, indicating some mode of cultural transportation of these chert-artifacts to 23HE9. The diagnostic artifacts found denote the Archaic period, a time when nomadic hunter-gatherers were intensively exploiting the natural environment. Thus, the evidence from 23HE9 generally supports the hypothesis that the utilization of chert resources was directly related to availability and proximity. However, as a result of this study, the word "directly" would be deleted and the hypothesis would be revised to: the prehistoric inhabitants of 23HE9 predominantly utilized locally available chert resources but not to the exclusion of non-local and exotic cherts. The initial hypothesis does not allow for the conservation and transportation of certain chert-artifacts by wide-ranging nomadic groups or trade systems, which is strongly suggested by the presence of non-local and exotic chert-artifacts at 23HE9.

SR400 CHERT SURVEY (AVAILABILITY)

Territory SR400 (Fig. 12) is located in St. Clair Co. in the southwestern corner of the Osceola Quadrangle at the confluence of the Sac and the Osage Rivers. The territory circle is roughly divided into three sections. The Osage River first bisects the territory west to east across to the eastern edge of the circle where it is joined by the Sac River, whereupon it then turns northwest bisecting the northern half into NW and NE sections. The SW section is defined as the peninsula between the Sac and Osage rivers.

Nine chert sites were recorded within SR400. Five of these sites were sampled from residuum deposits — all on the Mo formation; three were sampled from in situ bedrock exposed in a cut bank produced by the Osage River of which two were Mk and one was Mo; and the last site was sampled from a stream deposit of Ojc, Mk, and Mo chert nodules.

The Ojc formation does not outcrop within this territory. The closest Ojc outcropping is about 2 km south on the Sac River. Although in situ and residual Ojc chert is not immediately available within SR400, stream deposited Ojc is available in the territory along the shorelines of both the Sac and Osage rivers.

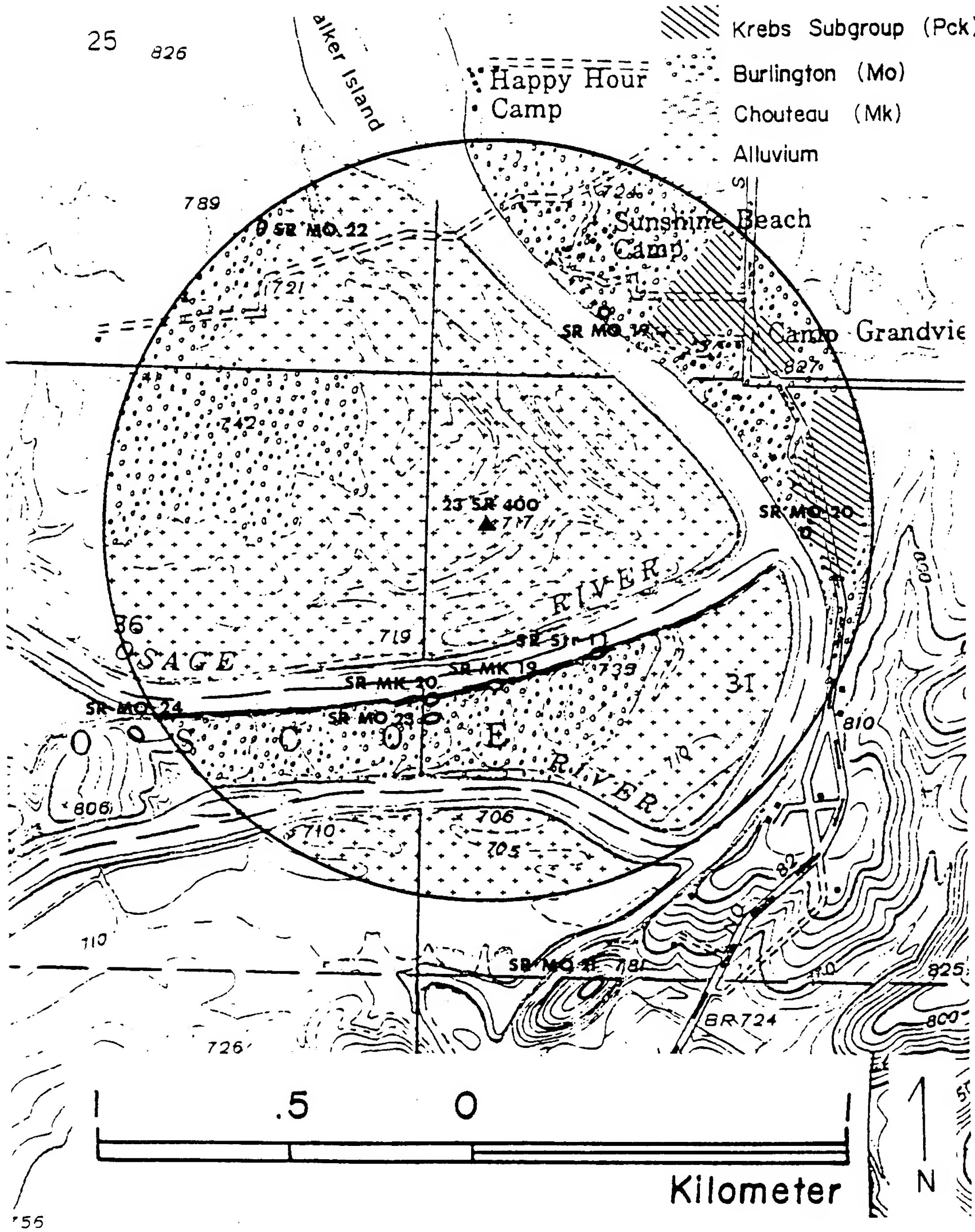

Figure 12. Chert Survey of Territory SR400.

Chouteau chert was found to occur almost exclusively in bedrock in the Osage River cut bank and in a stream deposit in the SW section. This is due to the fact that only the upper 2-3 m of the Mk formation outcrops above the 700' (base) level in this section (Plate 5c). The quality of the Mk chert ranges from predominantly poor fractured material to a small quantity of good quality material.

The Mo chert in SR400 is predominantly of poor quality – usually highly weathered, porous, hard, and coarse-grained. Generally, only about 5% of the surface residuum, which is usually quite dense (Plate 5b), is of good quality. At chert site SR Mo 20, on the other hand, part of the chert sampled was recently exposed subsurface residuum of which about 50% was relatively unweathered, fine-grained, good quality material. Burlington was the only chert-bearing formation that was found to exist in the NW and NE sections. It outcrops from 700' (base level) to 800' and 830', respectively. Burlington is also the only residual chert resource in the entire territory. One additional residual chert site (SR Mo 21) outside the territory (south) also yielded highly weathered, practically unworkable chert.

One stream deposited chert site along the Osage River was sampled at SR Str 11 in which all three local chert types (Ojc, Mk, Mo) were represented.

In the NE section, the top 1.5 to 5 m of the cut bank is capped by a Pennsylvanian sandstone (Pck).

Because the surface residuum is of such poor quality in SR400, the most productive source of good quality chert would probably be subsurface residuum (obtainable by quarrying below the frost-line). This source could be supplemented by stream deposited and bedrock chert sources.

The initial prediction of expected artifactual chert percentages for archeological sites within SR400 was: 7% Ojc, 13% Mk, and 80% Mo. However, after a reconsideration of both intra- and extra-territorial chert resources, these chert percentages were revised to: 21% Ojc, 29% Mk, 49% Mo, and 1% Mm. Several factors influenced the percentage revision. First of all, according to the Geologic Map of Missouri (Anderson, et al. 1979) both the Ojc and Mk formations outcrop only 2-3 km south of the territory along the Sac River, and the Mk formation outcrops only 5-7 km west of SR400 along the Osage River. In addition to these potential residual and in situ Ojc and Mk sources upstreams, stream bed Ojc and Mk chert redeposited by the Sac and Osage rivers is expected to have played a larger role in availability and procurement than indicated by the Chert Survey, conducted when the rivers were backed up by the filling reservoir. Warsaw (Mm) chert was minimally added to the list since this

formation does outcrop but at a substantial distance upstream on both rivers. The last consideration was the fact that the vast majority of the Mo chert exposed as surface residuum was of poor knapping quality.

One new archeological site (23SR776) was surveyed and recorded and two previously recorded sites (23SR520 and 23SR521) were resurveyed during the chert reconnaissance of SR400. The new site is located on a high cut bank 120'-130' directly above the confluence of the Sac and Osage Rivers and within chert site SR Mo 20. All of the surface artifacts were collected from this site. Of the thirty-seven total artifacts, twenty-nine were made from Mo chert, and four each were made from Mk and Ojc cherts. It was noted that most of the Mo artifacts were very similar to and probably knapped from local Mo chert.

The debitage was so dense on the two resurveyed sites that only small samples were collected. Site 23SR520 is located on a small knoll above chert site SR Mk 19. A total of 124 artifacts were recovered; fifty-five or 44.4% including one projectile point were Mk artifacts, forty-seven or 37.9% were Mo artifacts, and twenty-two or 17.7% including two projectile points were Ojc artifacts. Ground cover at the time of the survey was about 65% because the knoll was planted in milo .75 m high.

The 100 artifacts collected from 23SR251 located in a soybean field above chert site SR Mo 23 were chert typed and separated into fifty-two Mo flakes, thirty-four Mk flakes, and fourteen Ojc flakes.

The actual chert percentages exhibited in the samples from 23SR520 and 23SR521 correlate relatively well with the predicted percentages calculated for SR400. At 23SR776 the presence of eight Ojc and Mk artifacts on top of the steep cut bank 125' above the nearest Ojc-Mk chert source and 2-3 km north of any substantial Ojc-Mk outcroppings, is more hard evidence of procurement and transportation of chert — often to extremely high and unexpected places.

23SR400 ARTIFACTUAL ANALYSIS (UTILIZATION)

Archeological site 23SR400 is a surface site, which means all of the artifacts were collected from the surface of the ground and, therefore, have no temporal or spatial control due to natural and/or cultural (agricultural) disturbance processes. A total of 350 artifacts was recovered from the surface of 23SR400 and all were analyzed to chert type. Thirty-eight artifacts were identified as tools and 312 artifacts were classified as debris. A chert type composite of all the artifacts from 23SR400 is presented in Table 19.

TABLE 19

Total Artifact Composite for 23SR400

	Projectile Point	Biface	Scraper Unifacial	Core Flaked	Burin	Knife	Shatter	Flake Primary	Flake Secondary	Flake Tertiary	Flake Tertiary Bifacial Trim	Total No. Artifacts	Total %
Mo	3	9	2	-	1	1	40	3	5	141	1	206	58.9
Mk	2	2	1	5	-	2	7	2	1	33	-	55	15.7
Ojc	1	5	1	2	-	-	11	1	8	32	-	61	17.4
Indeterminate Mississippian	-	-	-	1	-	-	2	-	-	1	-	4	1.1
Indeterminate	-	-	-	-	-	-	3	1	1	19	-	24	6.9
Total	6	16	4	8	1	3	63	7	15	226	1	350	100.0

The chert-type analysis of the artifactual data from 23SR400 reveals a predominant utilization of Mo chert (58.9%) as predicted and a nearly equal utilization of Ojc (17.4%) and Mk (15.7%) cherts. A small number of artifacts (6.9%) were indeterminant as to chert type, and 1.1% of the artifacts were determined to be made from Mississippian-age chert but were unidentifiable as to specific formation (they may, however, be made from non-local Warsaw chert). A chi-square comparison between the predicted and observed chert-artifact percentages for 23SR400 (Table 20) reveals that the probability of cherts having been used in proportion to their availability is less than .001. Thus, the null hypothesis that chert use is proportional to its availability is rejected. Although the utilization percentage of Ojc chert was close to the expected, it appears that there was a much greater use of Mo chert than predicted and much less use of Mk chert than expected. The greater than expected use of Mo chert may be due to Mo's greater availability (accessibility, proximity, and abundance) within SR400 than Mk and Ojc chert types. It may also be due in part to an underestimation of the potential of the Mo chert resources within SR400 during the revision of the chert percentage predictions, being over-influenced by the poor quality of the surface Mo residuum generally found in the area and not accounting enough for relatively unweathered good quality subsurface Mo residuum (such as the deposit discovered at chert site SR Mo 20). The lower than expected utilization of Mk chert is probably due to its predominantly poor quality, relative inaccessibility and limited outcrops in the territory, and possibly to the skewed revised predictions.

A chi-square test (Table 21) was conducted to determine whether artifact types (tool/debris) are nonrandomly associated with chert types. The results show that at the .05 level of probability, artifact types are nonrandomly distributed among chert types and that the cells responsible for the significant chi-square value are two tool cells. Apparently, more tools were made from Mk chert than expected and less tools were made from Mo chert than expected.

There were six projectile points collected from the surface of 23SR400: three are made of Mo chert, two are made of Mk chert, and one is made of Ojc chert. Of the three Mo chert-artifacts, one is an unidentified point type, one is an unidentified corner-notched point, and one is a Snyder-like Woodland point. One of the Mk chert-artifacts is classified as a Stone Square Stemmed point type which is thought to date to the Late Archaic period, and the other is an unidentified corner-notched point. The one Ojc chert-artifact is an unclassified straight stemmed point.

There is evidence of heat treatment at 23SR400 since 31 artifacts were identified as being thermally altered —

TABLE 20

Chi-Square Analysis of 23SR400 Chert-Artifacts

Chert Type	Observed %	Predicted %	O	E	$\frac{(O-E)^2}{E}$
Mo	64.0	49	206	157.78	14.74
Mk	17.1	29	55	93.38	15.77
Ojc	18.9	21	61	67.62	0.65

Chi-Square = 31.16 df = 2 $p < .001$

TABLE 21

Chi-Square of Tools and Debris Chert Types at 23SR400

A. Frequencies

Artifact Type	Chert Type Mo	Mk	Ojc	Total
Tools	16	12	9	37
Debris	190	43	52	285
Total	206	55	61	322

B. Chi-Square Values

Artifact Type	Chert Type Mo	Mk	Ojc
Tools	-2.48	+5.10	+.56
Debris	+ .32	- .66	-.07

Chi-Square = 9.19 df = 2 .025 > p > .01

58% of these were heat treated Mo chert-artifacts. Bifaces were favorite tools to heat treat; six of the nine Mo bifaces were heat treated. There is also some evidence for the utilization of redeposited chert since a few pieces of each chert type (including the indeterminants) were identified as derived from a riverine source.

In sum, the artifactual analysis indicates a predominant utilization of the locally available and abundant Mo chert at 23SR400, although greater than expected. The Ojc and Mk chert types were evidently supplemental chert resources, obtainable from only limited local bedrock and stream deposited sources or from extra-territorial sources. Since the vast majority of Mo surface residuum within SR400 was found to be highly weathered, coarse-grained, poor quality material, and the subsurface Mo residuum was generally found to be good quality chert, the major source of chert was probably subsurface (Mo) residuum. The artifactual evidence also indicates that stream deposits (gravel bars) were a supplemental source of chert and that heat was sometimes used to temper chert – especially the variable Mo chert. Only two projectile points from 23SR400 were definitely correlated to a time period: one Mo projectile point was classified as a Snyder-like Woodland point and one Mk projectile point was identified as a Stone Square Stemmed, Late Archaic point.

23SR653

SR653 CHERT SURVEY (AVAILABILITY)

Territory SR653 (Fig. 13) is located in St. Clair County on the west-central edge of the Iconium Quadrangle 1.5 km southeast of the confluence of Weaubleau Creek and the Osage River. The western-most edge of the territory circle overlaps slightly into the Osceola Quadrangle. The territory is bisected southeast-northwest by Weaubleau Creek. The upland area north and east of Weaubleau Creek was designated the NE quadrant and the bottomland south of it was called the SE quadrant. The ridge system south and west was designated the SW quadrant. A small area north and west of old Route 82 on the west side of Weaubleau Creek was called the NW quadrant.

A total of twelve chert sites was recorded within SR653. Nine of these sites were sampled from residuum; four sites were on the Mo formation, four were on the Mk formation, and one was located on the Ojc formation. One *in situ* bedrock site was sampled from the Ojc formation in the NW quadrant. Two stream bed deposits were sampled and in each case only Mk and Mo nodules were present.

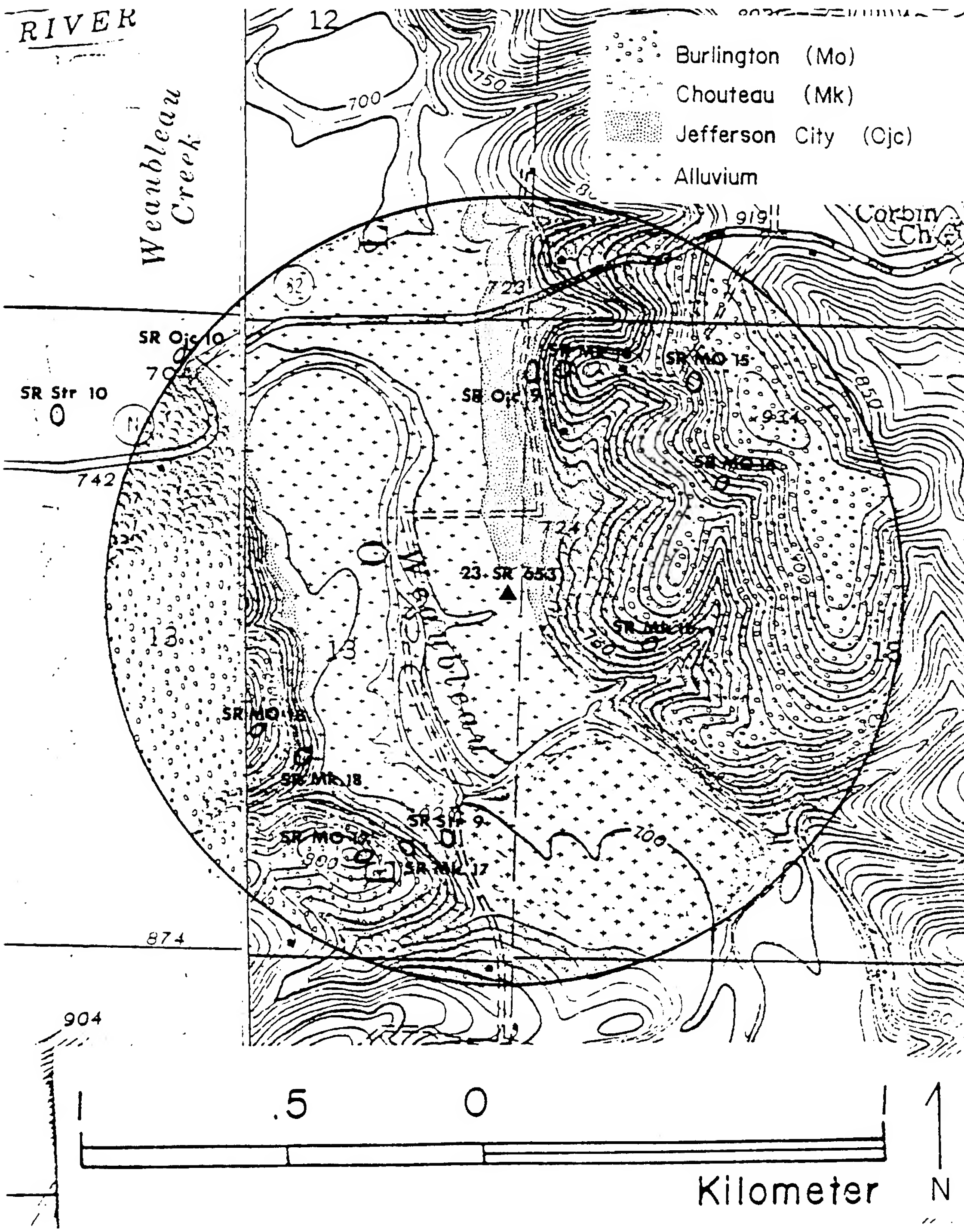

Figure 13. Chert Survey of Territory SR653.

According to the Geologic Map of Missouri (Anderson, et al. 1979), the Ojc formation does not outcrop along this portion of Weaubleau Creek. However, as discovered by the Chert Survey of SR653, the Ojc formation does outcrop along the lowermost portions of the slopes in the Weaubleau Creek Valley in this area. The formation varies in elevation from only floodplain level (700') in the southernmost part of the territory up to approximately 730'-740' in the northern part of the territory. Still, much of the Ojc formation along the lower valley slopes is inaccessible due to masking environmental factors such as alluvium and colluvium. The Ojc chert sampled from the one residual site usually occurred in fairly small flat ellipsoidal tabular nodules and was mostly good to excellent quality. The in situ Ojc chert at SR Ojc 10 occurred in small flat lenticular nodules, discontinuous seams, and as "free" nodules, but they were usually too small to use as productive cores.

The Mk chert sampled within SR653 was mostly a light colored variety (a mottled light and medium gray) which has a coarse, grainy or silty texture. This characteristic in addition to its usually fractured blocky nature generally produces the common poor quality. There is an absence of chert at the Mk-Mo contact in this area. This is due to the fact that the upper three meters of the Mk formation is usually relatively devoid of chert nodules, in addition to the one meter thick Northview shale.

The Mo chert sampled at four sites in SR653 was basically of poor quality when it occurred as surface residuum. The nodules were predominantly hard, porous and highly weathered. However, the Mo chert density in this territory was usually rather high (about 35%). As discovered in several other territories in the reservoir area, subsurface Mo residuum was of much better quality than Mo nodules exposed at the surface. At chert site SR Mo 15, part of the Mo sample was taken from exposed subsurface residual nodules in the sides of a recently cleaned ditch along a roadway. The quality of these disturbed residual nodules was frequently good, due to the original provenience below the frost-line. In contrast, the surface residuum sampled on the hillside was mostly highly weathered poor quality material.

Based on the evidence from the Chert Survey of SR653, residuum was probably the major source of chert exploited within the territory. It is the most productive chert source since it is readily available in great quantities. Quarrying subsurface residual nodules below the frost-line would yield an even better source of chert. Good quality stream deposited chert usually occurred in low percentages (2-10%) and was therefore probably not exploited as extensively as residual chert.

The strata in SR653 appear to be dipping to the south and west. The three formations are as much as 30' lower in elevation in the southern and western portions of the territory than they are in the northeastern portion. The Ojc formation outcrops from 690' (base level) to about 740' in the northern part of the NE quadrant, whereas it outcrops up to only 710' in the southern part of the same quadrant. In the NW and SW quadrants, Ojc outcrops from base level up to 715' and 710' respectively. The Mk formation outcrops from about 740' to 830' (northern portion) and 710' to 780' (southern portion) in the NE quadrant, and 710' to 750' or 780' in the SW quadrant. The Mo formation outcrops between 830' or 780' to 935' in the NE quadrant, and from 750' or 780' to 880' in the SW quadrant.

The initial artifactual chert percentage prediction for 23SR653 was: Ojc - 10%, Mk - 30%, and Mo -60%. However, after a reconsideration of all possible chert resources, these percentages were revised to: Ojc - 22%, Mk - 33%, and Mo - 45%. The revision is based on the fact that Ojc outcrops become thicker northward, and only a short distance (1.5 km) downstream larger quantities of both residual and stream deposited Ojc chert is potentially available. An additional source of Ojc chert available within SR653 is redeposited chert derived from localized fault outcrops upstream along Weaubleau Creek. Another factor affecting the revision is the generally poor quality of the local Mk and Mo cherts.

Two new archeological sites were found and recorded during the chert reconnaissance of SR653. At 23SR777, ten Mo artifacts were found on a ridge saddle about 100 m SSW of chert site SR Mo 16 — all Mo artifacts on the Mo formation.

At 23SR784 located within chert site SR Mo 17 on a high knoll, eighteen artifacts were recovered. Fifteen of these were made from Mo chert and one Mo flake had been knapped from a river cobble. The remaining three artifacts were Ojc flakes. The three Ojc flakes and the one Mo flake from a stream deposited nodule obviously had to have been carried in one form or another 110' upslope to the summit of the site of deposition.

23SR653 ARTIFACTUAL ANALYSIS (UTILIZATION)

Archeological site 23SR653 is a surface site which means all of the collected artifacts have no temporal or spatial control due to natural and/or cultural (agricultural) disturbance processes. This site was originally divided into two areas (A and B), but for the purposes of this chert study they were combined. A total of 47 artifacts was recovered from the surface of 23SR653 and all were analyzed

as to chert type. The chert of each artifact was easily identified since they were all typical of the three local chert types. Forty-four artifacts were identified as tools; only three artifacts were classified as (tertiary) flakes – two Ojc and one Mo. The reason for the bias toward tools is because of the particular collection strategy employed at the time of the location of the surface site, which was to collect only the potentially diagnostic artifacts. A chert type composite of all the artifacts from 23SR653 is presented in Table 22.

The chert analysis of the artifactual data reveals a predominant utilization of Mo chert (42.6%), followed by Ojc chert (34.0%) and finally Mk chert (23.4%). A statistical comparison between the expected and observed percentages (Table 23) shows that at the .05 level of probability the data are not significantly different from the predicted. As Table 23 indicates, it appears that there was an even higher preference or selection for Ojc chert and less for Mk chert than expected. This heavier than expected reliance on Ojc chert may be due to its much better overall quality than the local Mk chert, even though the Mk chert is more abundant within the territory. The utilization of Mo chert was very close to the prediction.

It is noteworthy that half of the artifacts (all three chert types) from this site exhibited obvious signs of heat treatment and most of these were bifaces. It is also interesting that all five of the artifacts identified as manufactured from stream cobbles were made from Ojc chert. This is not surprising, however, since one of the major sources of Ojc chert in this area is stream bed chert derived from localized fault outcrops upstream along Weaubleau Creek. Unfortunately, no projectile points were found at 23SR653 and thus no time period could be established for the occupation of the site.

In sum, although the collection procedure for 23SR653 does bias the technological (tool/debris) data, it should not bias the chert related data on tools since there was no biased selection for certain chert types. Therefore, the tool chert type analysis indicates the utilization of the local chert resources at 23SR653, predominantly the readily available and abundant Mo chert (probably subsurface residual nodules) as expected. The greater utilization of Ojc chert than Mk chert is probably because of preference due to its better quality and because of its greater availability and abundance only a short distance downstream to the north. Thus, the evidence generally supports the economizing hypothesis with a slight modification due to varying chert qualities. There is also evidence for the frequent application of heat to all three chert types and some utilization of stream deposited (Ojc) chert at 23SR653.

TABLE 22

Total Artifact Composite for 23SR653

	Biface	Scraper Unifacial	Scraper Bifacial	Core Flaked	Knife	Cleaver	Flake Tertiary	Total No. Artifacts	Total %
Mo	14	3	1	-	-	1	1	20	42.6
Mk	6	3	1	1	-	-	-	11	23.4
Ojc	7	3	1	1	2	-	2	16	34.0
Total	27	9	3	2	2	1	3	47	100.0

TABLE 23

Chi-Square Analysis of 23SR653 Chert-Artifacts

Chert Type	Observed %	Predicted %	O	E	$\frac{(O-E)^2}{E}$
Mo	42.6	45	20	21.15	.06
Mk	23.4	33	11	15.51	1.31
Ojc	34.0	22	16	10.34	3.10

Chi-Square = 4.47 df = 2 $.25 > p > .10$

23BE660

BE660 CHERT SURVEY (AVAILABILITY)

Territory BE660 (Fig. 14) is located in Benton County in the west-central portion of the Shawnee Bend Quadrangle at the confluence of Tebo Creek and the South Grand River. Since the territory is situated at the junction of two major streams, about 75% of the topography within the territory circle consisted of wide valleys with their concomitant broad bottomlands. Because of this topography and due to the rising pool level of the filling reservoir (approximately 695' at the time of the survey), most of BE660 was inundated and thus inaccessible and unsurveyable. However, seven chert sites on two sides of the broad valley (in the NE and SW quadrants) were sampled and recorded; the NW and SE quadrants were inundated.

Of the seven sites recorded, six were sampled from residual chert and one was sampled from stream deposited chert. The six residual sites consisted of two sites each on the Ojc, Mk, and Mo formations. The one stream deposited site included nodules from all three local cherts, however, only Ojc seemed to occur in knappable nodules. From the information available, residual chert nodules were most likely the major chert source utilized.

The Ojc chert in the NE quadrant was variable with mottled, banded, and very oolitic varieties. Several Ojc nodules occurred in "cabbage head" form. The chert density was estimated to be about 30% with most nodules being of fair to good quality. The Ojc chert in the SW quadrant was largely conglomeritic causing the quality to be basically poor.

The Mk chert in both quadrants was generally of poor quality because most of it was fractured and highly weathered. Chouteau chert in this territory was very fossiliferous which contributed to the poor quality.

Both basal Mo and Mo proper were sampled in the NE and SW quadrants. The basal Mo had a low chert density and the chert usually occurred in small nodules and was basically unknappable. The regular Mo chert, on the other hand, occurred more frequently and in larger nodules and was of better quality.

The three chert-bearing formations outcrop at slightly different elevations on the NE and SW sides of the river valley. In the NE quadrant, the Ojc formation outcrops from 660' (base level) to 780', the Mk formation outcrops between 780'-820', and the Mo formation outcrops from 820' to the top of the bluff at 845'. Each formation outcrops 20' lower in elevation on the SW side of the valley above the confluence

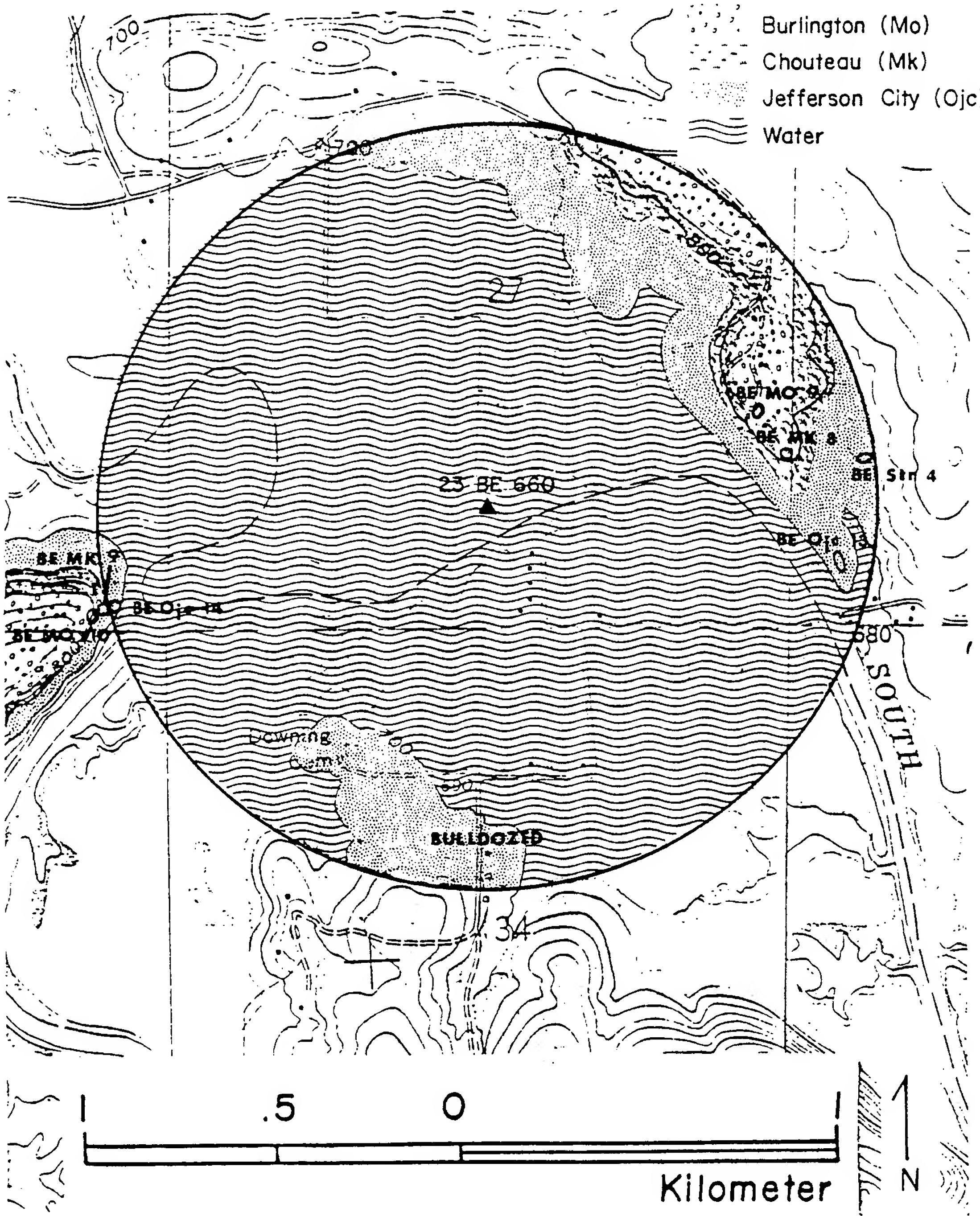

Figure 14. Chert Survey of Territory BE660.

of Tebo Creek and the South Grand River. The elevations of the Ojc, Mk, and Mo formations established for BE660 by the Chert Survey are nearly identical to those mapped by McMillen (1950) for the same area. The stream deposited chert site (BE Str 4), which included all three chert types, was sampled in an intermittent stream at 730' in the NE quadrant.

Based on the chert reconnaissance, the percentage predictions for BE660 are: Ojc chert should occur in 80% of the artifacts, Mk chert should occur in 10% of the artifacts, and Mo chert should occur in 10% of the artifacts.

Two archeological sites and one isolated find were found during the survey of BE660 – all in the NE quadrant. At chert site BE Mk 8, the nine artifacts recovered were all made from Ojc chert. The area within BE Mk 8 where the nine artifacts were collected was designated 23BE905.

At the top of the bluff on chert site BE Mo 9, a dense accumulation of artifacts was encountered. Both a general surface collection and intensive surface collection were conducted on this archeological site designated 23BE907.

The initial general surface survey consisted of collecting usually the largest and most obvious artifacts visible on the surface of the site, which was approximately 30 x 30 m. About thirty minutes were spent collecting a total of 243 artifacts. Of these 243 artifacts the vast majority, 82.7% (201 artifacts), were made from Ojc chert, 12.4% (30 artifacts, including one projectile point) were manufactured from Mo chert, and only 4.9% (12 artifacts) were made from Mk chert.

One week later an intensive surface collection was conducted in which all artifacts (almost 500) were collected within a 10 x 10 m square located on the area with the heaviest concentration of artifacts. Although ground cover was about 60%, the surface litter was scratched away in most places to get at the artifacts. An overwhelming 84.3% (420 artifacts, including one projectile point) of the total 498 artifacts collected were made from Ojc chert, whereas, only 12.1% (60 artifacts) were made from Mo chert and 3.6% (18 artifacts) were made of Mk chert. The chert percentages represented in the intensive surface collection (whose sample doubled the general collection sample) were very close to the general surface collection percentages; they varied less than two percentage points in each chert class. The artifactual evidence from 23BE907 indicates a clear preference and heavy utilization of Ojc chert, some utilization of Mo chert, and very little utilization of Mk chert. The evidence further indicates obvious procurement and transportation of large amounts of Ojc chert to higher elevations (at least 45') for lithic reduction. The actual utilization of

available chert resources as manifested in the artifacts recovered from 23BE907 closely matches the expected percentage predictions presented earlier.

The one isolated find located on chert site BE Ojc 13 included six artifacts made from Ojc chert – four flakes and two cores.

23BE676

BE676 CHERT SURVEY (AVAILABILITY)

Territory BE676 (Fig. 15) is located in Benton County in the southwestern corner of the Shawnee Bend Quadrangle where old Route 7 crossed the South Grand River (Long Shoal Bridge). The new Route 7 road and bridge transects the easternmost portion of this territory. A total of 30 chert sites were recorded within and just outside BE676. Twenty-two (eight Ojc, six Mk, eight Mo) of these sites were sampled from residuum, five (two Ojc, one Mk, two Mo) were sampled from *in situ* bedrock exposed in stream cuts, and three were sampled from stream deposit gravels.

Four quadrants were defined and sampled during the Chert Survey. The NE quadrant consisted of alluvial bottomlands on the inside of a meander of the South Grand River. This quadrant was largely inundated by the existing pool level of the filling reservoir which was about 690'. In addition most of the remaining land above water had been bulldozed or otherwise disturbed by heavy machinery. Therefore, three of the four sites sampled in this area were located just outside the quadrant's perimeter. Jefferson City is the only formation that outcrops within the NE quadrant. No significant chert resources were found. The chert that did occur scattered about on the surface was mostly small alluvially deposited gravels and some generally poor grade Ojc residual nodules.

The SE quadrant was defined as the ridge system east of the ponded stream south of 23BE676. All three local chert-bearing formations (Ojc, Mk, Mo) outcrop in this quadrant. The four Ojc sites sampled revealed abundant supplies of good quality residual chert. The four Mk sites, on the other hand, revealed mostly poor to some fair quality chert, and the five Mo sites exhibited, on the average, fair quality chert.

The SW quadrant consisted of a long narrow interfluve between the ponded stream on the east and a northeastward flowing intermittent stream on the west. All three local chert types were also found in this quadrant. The one residual Ojc site sampled (BE Ojc 7) contained a high concentration of good quality chert nodules that were mostly in

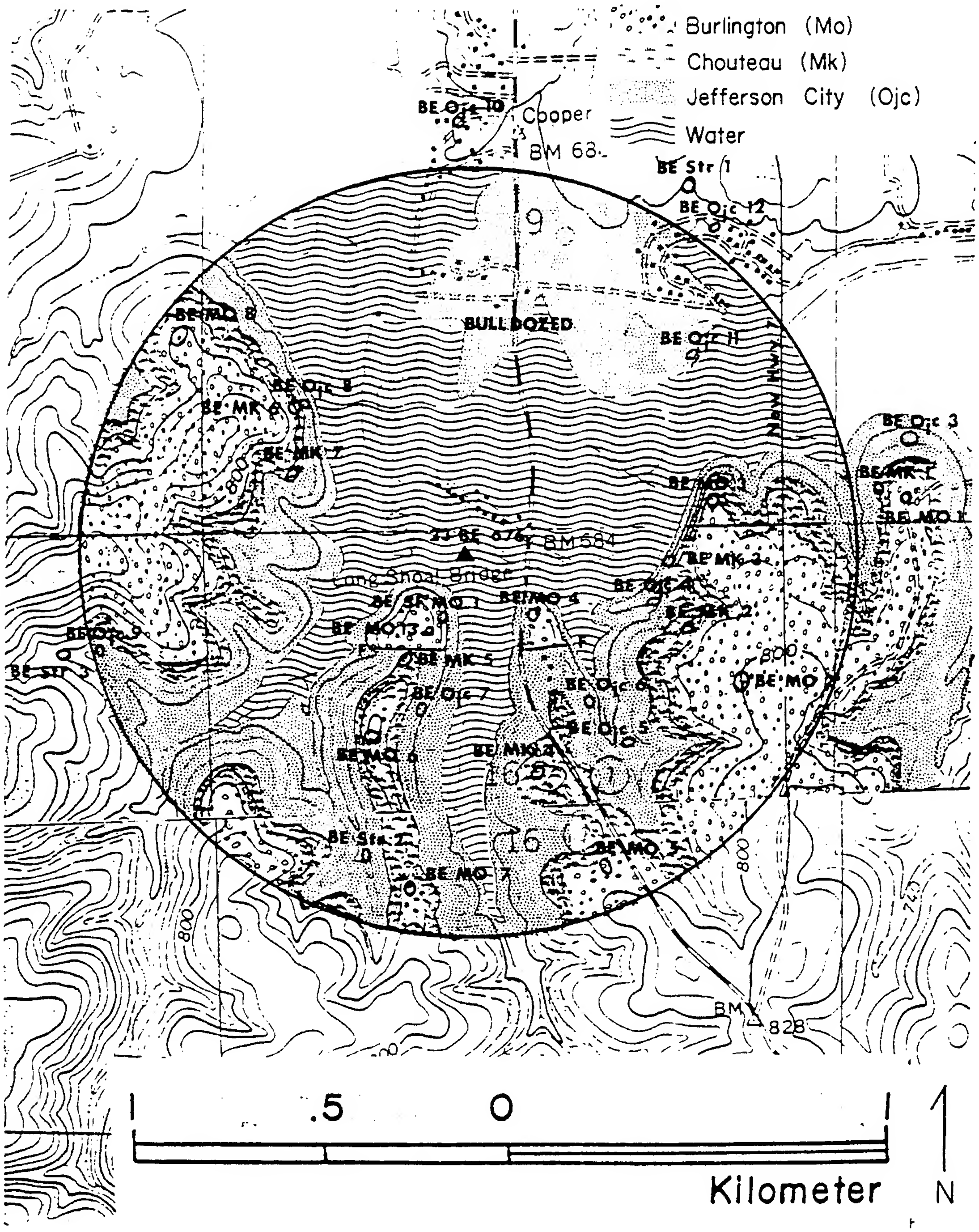

Figure 15. Chert Survey of Territory BE676.

"cabbage head" form and oolitic — an excellent source of chert. The Mk residuum on this ridge had a blocky structure and was weathered. The Mo residuum generally exhibited fair to good quality in this quadrant.

The NW quadrant refers to the fingering interfluve north of the northeastward flowing creek. Again, all three chert types were present in this quadrant. The Ojc and Mk sites sampled had fair to good quality chert, but the majority of the chert at the Mo site was rather coarse-grained and weathered. A sample of redeposited chert was taken in a small creek at 730' elevation in which all three cherts were represented in equal proportions.

Except for a fault zone on the northern ends of two ridges near the center of the territory, the Ojc formation generally outcrops from base level (660') to around 740', the Mk formation usually outcrops from about 740' to 780', and the Mo formation outcrops from approximately 770' or 780' to the ridge tops — to 800' in the SE quadrant and 860' in the NW quadrant. At the faulted zone near the center of the territory (Fig. 15), Mo limestone is situated at a lower elevation (700'-740') than the adjacent Mk limestone and on the end of the ridge in the SE quadrant Ojc dolomite is directly overlain by basal Mo. This phenomenon is probably due to normal block faulting. Referring to the structure of the Ojc formation in the Shawnee Bend Quadrangle, McMillen (1950: 11) notes, "there are small localized areas associated with the Burlington limestone where the direction and amount of dip is very erratic."

In regard to McMillen's 1950 study, it has been determined by this survey that his geologic map's elevations for the three local formations within territory <u>BE676</u> are at least 20' too high.

In summation, after a fairly extensive chert survey of <u>BE676</u>, it has been determined that there is a plentiful supply of good quality chert within a 1 km radius of 23BE676. An especially good quality chert source is the abundant residual Ojc chert nodules usually found mantling the lower portions of interfluves and hillsides from the alluvial valley floor (660') to about 740' elevation, all on the south side (cut bank) of the South Grand River. Another potentially good chert source possibly exploited by prehistoric peoples within the immediate vicinity of <u>BE676</u> is much of the residual Mo which caps most of the interfluves from around 775' to the ridge tops. Chouteau chert exists, often in substantial quantities, but is generally of questionable quality due to common incipient fracture planes; it usually outcrops from about 740'-780'. Stream deposited chert is another potentially exploitable chert source bearing all three local cherts; however, it would seem one step less

desirable than residual chert since it has been subjected to abrasive battering and accelerated weathering. In situ chert exists but is minimal compared to residual and redeposited chert and much harder to procure.

Based on the evidence obtained from the Chert Survey, Ojc chert has been predicted to occur in 75% of the artifacts, Mk chert to occur in 10% of the artifacts, and Mo chert to occur in 15% of the artifacts.

Five archeological sites and four isolated finds were found during the survey of BE676. At chert site BE Mo 1 on top of the ridge, ten artifacts were found – five made from Ojc chert, two made from Mk chert, and three from Mo chert (23BE902).

On top of the bluff in the SE quadrant at chert site BE Mo 3, twenty-eight artifacts were collected. Nineteen of these artifacts were knapped from Ojc chert, whereas, only three were made from Mk chert and six from Mo chert. This artifactual evidence is positive proof of procurement and transportation of Ojc and Mk chert to this location since Mk and especially Ojc occur naturally several meters below the top of the bluff and the Mo formation. The archeological site was designated 23BE903.

Within chert site BE Mo 6 on the south side of the highest point on the narrow ridge in the SW quadrant, 23BE904 was found and recorded. During a general surface survey of the entire site and later an intensive surface collection of a 3 x 3 m area, twenty-four Ojc artifacts and fifty-three Mo artifacts were found. Ground cover within the 3 x 3 m area was about 35-40%. Although an admittedly small sample, it appears that even though Ojc chert was used, the immediately available Mo chert was utilized the most.

North of 23BE904 on the same ridge another site (23BE906) was intensively surveyed within chert site BE Mo 13. Ground cover was approximately 15-20%. The 9 m (N-S) x 4 m (E-W) area intensively collected yielded a total of eighty-two artifacts, of which the predominant chert type was Ojc, (84.1%) followed by Mo chert (11%) and Mk chert (4.9%).

On another ridge top in the NW quadrant a small quantity of artifacts (thirteen) were found at 23BE909 within chert site BE Mo 8. Here, the dominant chert type was Mo (eleven artifacts) with Mk and Ojc chert types represented by only one artifact apiece.

The four isolated finds included three Ojc artifacts found on chert site BE Mo 2, a few Ojc flakes and one Ojc

biface fragment noted on BE Mk 5, three Mk and three Ojc artifacts located within BE Mk 7, and seven Mo artifacts found on BE Mo 7.

23BE681

BE681 CHERT SURVEY (AVAILABILITY)

Territory BE681 (Fig. 16) is located in Benton County in the northeast section of the Shawnee Bend Quadrangle 1.2 km south of the confluence of Flemming Branch and Little Tebo Creek. The territory is bisected north-south by the Little Tebo Creek valley. The east half of the territory is divided into NE and SE quadrants by a county road. The western portion of BE681 was designated the NW quadrant. The SW quadrant consisted of an alluvial floodplain.

A total of eighteen chert sites were recorded within BE681. Eleven of these sites were sampled from residual deposits – five on the Ojc formation, four on the Mk formation, and two on the Mo formation. Six of the chert sites were sampled from redeposited stream gravels; three of these sites contained all three local cherts, two sites contained only Ojc and Mk cherts, and one site consisted of only Ojc chert. The remaining chert site was sampled from *in situ* Ojc bedrock exposed by Little Tebo Creek.

The Ojc formation is the dominant lithologic unit within BE681. This formation outcrops nearly three-fourths of the way up the east valley slope and composes all of the terrain on the west side of the valley except for an undulating contact with the surface and small localized Mk remnants along the highest ridge. The Mk remnants in the NW quadrant are insignificant to chert procurement and utilization within BE681. The Ojc residual nodules varied in quality at every site from predominantly poor, fractured chert to good workable material. Although the majority of the Ojc residuum was poor to fair, some very good nodules existed but they had to be searched for among the more prevalent weathered nodules. In this locality, the top portion of the Ojc formation contains more oolitic chert than the middle and lower portions. Sandstone float from the Ojc formation separates the Ojc and Mk residual chert nodules in this territory.

The Mk formation outcrops on both sides of the Little Tebo Creek valley but predominantly and most significantly on the east side of the valley. In the SE and NE quadrants it occurs near the top of the slope in strata varying from 30 to 40' thick. However, Mk was probably a minor chert resource since most of its residuum is highly fossiliferous and it is generally of poor quality.

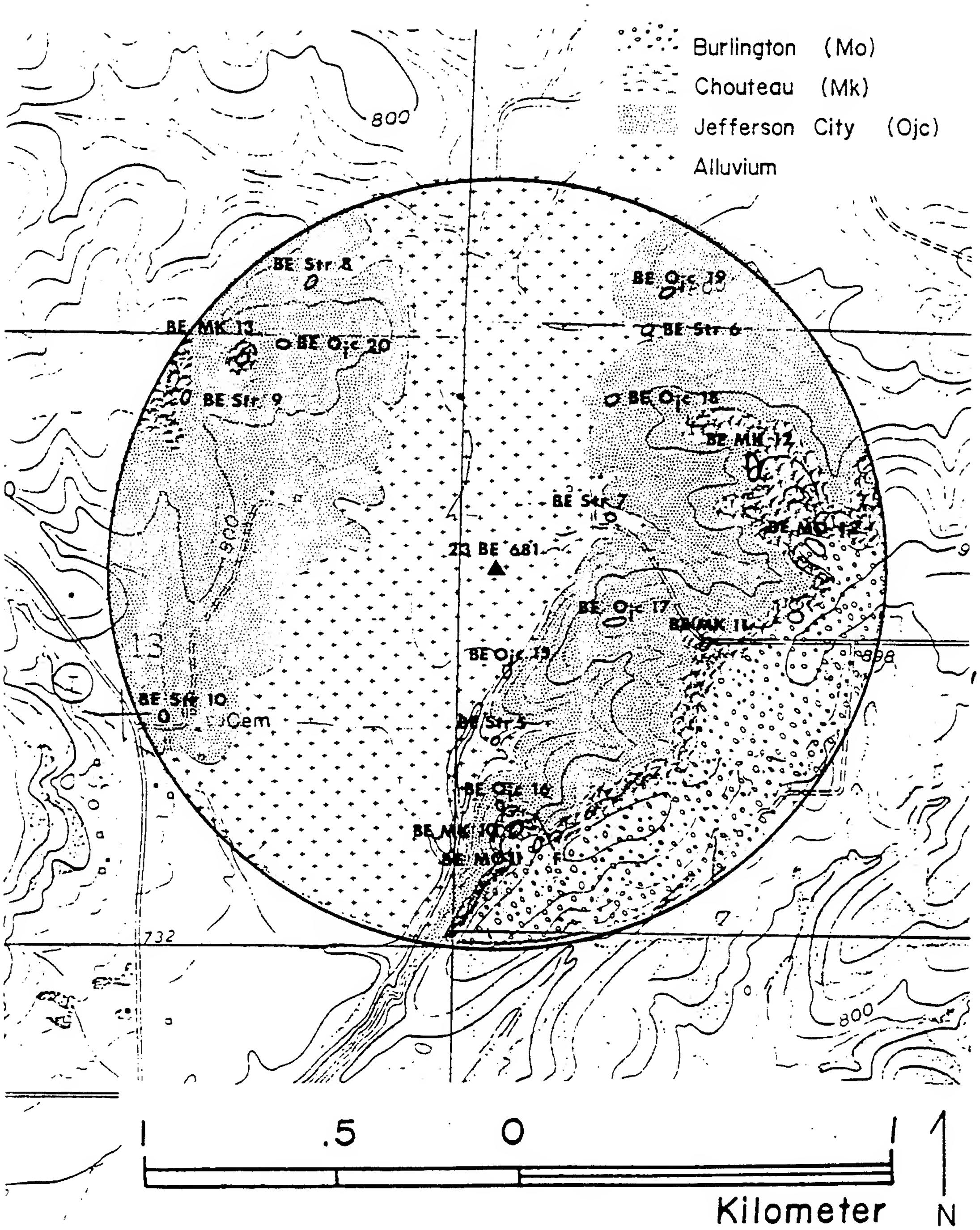

Figure 16. Chert Survey of Territory BE681.

The Mo formation is present only in the southeastern-most portion of this territory where it caps the last 20'-30' of the flat uplands. Most all of the residual Mo chert in BE681 is of very poor knapping quality, being highly weathered, hard to fracture, and often occurring in rather large nodules.

Six streams were sampled for chert types and quality within BE681. At each site, Ojc chert was dominant and was estimated to make up at least 70-75% of the total stream bed chert. The Mississippian cherts were usually present but were generally too weathered for flint knapping. Knappable Ojc nodules do occur but size is a limiting factor.

Although creek beds within BE681 were surely exploited as a source of chert, the most likely and productive source would be the Ojc residuum on the hillslopes, especially subsurface residuum.

The Ojc, Mk, and Mo formations outcrop at varying elevations in this territory. In the southwest part of the SE quadrant (Fig. 16), a fault has downdropped the southern section, moving formation boundaries downslope 30'-40'. Whereas Ojc outcrops from 700' (base level) to 840', Mk outcrops from 840' to 870', and Mo outcrops from 870' to 890' north of the fault line, all three formations outcrop about 40' lower south of the fault. My elevation estimations of formation boundaries and McMillen's geologic map's elevations correspond well in the SE quadrant. In the NE quadrant, the Ojc formation is 110' thick, the Mk formation is about 40' thick, and the Mo formation is approximately 30' thick. In the NW quadrant, Ojc outcrops from 710' to 850' and the Mk limestone is from 5'-10' thick in localized areas. McMillen's formation elevations in this quadrant are far off the mark since he has Mk outcropping at 780' and even Mo outcropping from 810' to the top of the ridge (850').

The artifact chert type percentage predictions for BE681 were calculated to be 85% Ojc, 10% Mk, and only 5% Mo.

Only one archeological site was found during the survey of BE681, located on the end of the ridge 200 meters ENE of chert site BE Ojc 20. This site, designated 23BE908, yielded eighteen Ojc artifacts and a piece of worked hematite. One isolated find of six Ojc artifacts was also noted on chert site BE Ojc 16.

A quick survey of a couple of cultivated fields north of 23BE681 was made to find out what types of chert were represented in the lithic debitage but no artifacts were collected. The vast majority of the flakes were Ojc and were most probably knapped from local resources since they closely resembled the natural Ojc chert sampled during the Chert Survey.

Several Ojc flakes were encountered in unlikely site locations on the slopes in the SE quadrant — a relatively thin continuous scatter probably indicative of prehistoric flint knappers testing chert nodules on the spot for quality and knappability.

23SR504 - 23SR675

SR504 - SR675 CHERT SURVEY (AVAILABILITY)

Since archeological sites 23SR504 and 23SR675 are located less than 200 meters apart, it was decided to situate the center of the 1 km radius chert territory in this area halfway between these two sites. Therefore, due to proximity and the fact that the same availability of local chert resources should pertain to both sites, the chert territory for this area was jointly designated SR504-SR675.

Territory SR504-SR675 (Fig. 17) in St. Clair County is situated on two quadrangle maps — located in the extreme northwestern corner of the Iconium Quadrangle and the extreme northeastern corner of the Osceola Quadrangle. The territory is bisected north-south by the Osage River. Most of the upland terrain was located in the northern portion of the eastern half and was designated the NE quadrant. The SE quadrant consisted of a broad floodplain. The western half was bisected by Wolf Creek, defining the NW and SW quadrants.

Twelve chert sites were recorded within SR504-SR675. Eight of these sites (5 Ojc, 2 Mk, 1 Mo) were sampled from residual chert, and the other four were sampled from stream deposited chert. An additional six residual sites were sampled outside the territory.

Except for the ridge tops in the SW quadrant, the Ojc formation covered the entire territory. Thus, basically only Ojc chert is available within the immediate area of 23SR504 and 23SR675, and there is often an abundant supply of good quality nodules mantling the slopes. Even though the chert usually ranges from excellent to predominantly poor quality, at least one-third of the total Ojc chert on four residual sites was judged to be of good quality. The Ojc formation outcrops from 680' (base level) to 830' in the NE quadrant, from 680' to 810' outside the NW quadrant, and from 680' to 770' and 800' in the SW quadrant.

The Mk chert was basically of poor quality at the two sites sampled in the SW quadrant. The Mk formation outcrops from 770' to 820' on the east slope of the ridge but outcrops from 800' to 850' on the west side of the ridge.

The residual Mo chert on the highest knob in the SW quadrant (the highest point within SR504-SR675) was

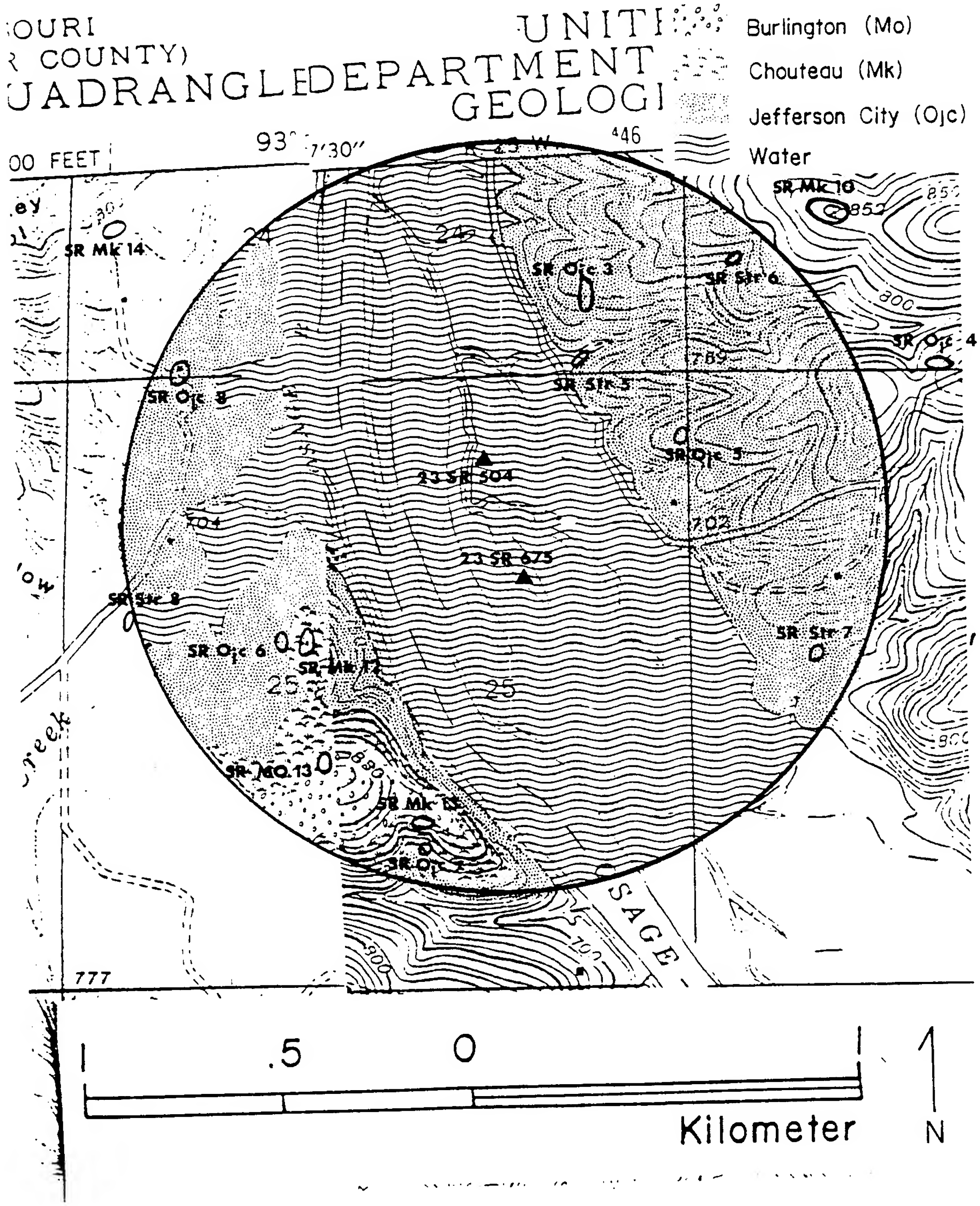

Figure 17. Chert Survey of Territory SR504-SR675.

predominantly poor quality, unknappable chert. The base of the Mo formation outcropped at 820' on the east side of the knob, but outcropped at 850' on the wide side and continued to the top of the hill at 875'. The strata in the SW quadrant apparently dips to the east at a significant enough angle to cause the three local formations to outcrop 30' lower on the east side of the ridge than on the west side, which is only about 0.5 km apart.

Three streams sampled in the NE and NW quadrants contained Mk and Mo cherts in addition to Ojc chert. Because of the presence of Mississippian cherts in the alluvial gravels of these creeks within the territory, it was obvious that the Mk and Mo formations outcropped somewhere upstream outside SR504-SR675; therefore, six residual sites (1 Ojc, 3 Mk, 2 Mo) were sampled outside the NE and NW quadrants on higher terrain to pinpoint their exact locations.

Outside the NE quadrant 0.2 km, the base of the Mk formation was found to outcrop at 840' on two different ridges. On both ridges a good source of high quality residual Mk chert was located. The Mk chert varied in texture and color from a slightly grainy light grey variety to a highly vitreous and lustreous dark grey to bluish-black variety, which was the best Mk found all summer. A high percentage of the Mk chert at both sites ranged from fair to excellent quality. The Mk-Mo contact was pinpointed at 890' and the Mo limestone continued to the top of the ridge at 940'. The Mo chert, however, was of very poor knapping quality.

The Mk residuum outside the NW quadrant, which outcropped between 810' and 850', again contained good quality chert but in much lesser quantities. The poor quality Mo residuum outcropped from 850' to 910'.

In order to determine the relative qualities and quantities of Ojc, Mk, and Mo chert nodules in a local stream deposit within SR504-SR675, an experiment was conducted at chert site SR Str 8 (Plate 7a), which will be discussed in detail in Appendix A ("Stream Deposited Chert Test"). A summary of the results reveals that although stream deposited chert should have provided a viable and usually readily accessible source of chert in SR504-SR675, the quality and quantity of the chert varies widely according to type. For example, Ojc chert was determined to be the most desirable chert type available in this particular stream deposited source, occurring in good knappable qualities and large quantities. On the other hand, even though a high percentage of good quality Mk chert nodules exists in this stream, it occurs in such negligible quantities that it was probably a minor chert resource; and although Mo chert nodules were the most abundant of the three, they were predominantly highly weathered and unknappable.

It was noticed during the survey of this territory that the contact zones between the three formations were usually located at the point of break in slope on hillsides, a probably lithologic control of topographic expressions. There is also usually a scarcity of chert at these contacts, due to intervening shale, siltstone, or sandstone layers.

It should be noted that in the NE quadrant where a recent fire had cleared most of the ground of leaf litter, grasses, and low brush, a distinct impression was made on us just how much more visible residual chert nodules were on this recently burned-over ground. It was remarked that procurement of residual chert would probably be much easier and selectivity facilitated after leaves, grasses, and low brush were eliminated. This may have been an added incentive to burning land in prehistoric times in addition to increasing land fertility and game procurement. Depending on the intensity of the fire and depth of the chert nodules in the soil, the fire may have beneficially heat treated the chert or negatively cracked and crazed the nodules.

Both the residual and stream deposited chert sources provide a potentially good source of knappable chert within SR504-SR675. However, an edge would be given to residual chert as the probable favored chert source because of its availability and non-subjection to riverine weathering processes.

Based solely on a survey of chert resources within the territory circle, the initial percentage predictions of artifactual chert were: Ojc - 85%, Mk - 10%, and Mo - 5%. However, after considering the good quality Mk chert resources located just outside the territory perimeter, the chert percentages were revised to: 75% Ojc, 20% Mk, and 5% Mo.

Three archeological sites and four isolated finds were found during the survey of SR504-SR675. At 23SR773 located on the Ojc formation, 15 Ojc artifacts (65.2%) and 8 Mk artifacts (34.8%) were found – an unusual percentage of Mk artifacts to be found on the Ojc formation.

At 23SR774 within chert site SR Ojc 8 a total of thirty-five artifacts were collected from an abandoned dirt roadbed and razed house site. Twenty-five (71.4%) of the artifacts were Ojc and ten (28.6%) were Mk artifacts.

Twenty Ojc artifacts were found on the summit of a hill capped by Mk limestone at chert site SR Mk 12. The area within SR Mk 12 where the artifacts were collected was designated 23SR775.

The four isolated finds consisted of four Ojc artifacts, one Mk biface, and one Mo flake found on chert site

SR Ojc 3, four Ojc and three Mk artifacts found on SR Mk 10, three Ojc artifacts noted to the southwest of SR Mk 14, and three Ojc plus two Mk artifacts located on SR Mo 13.

The artifacts collected from the three archeological sites within SR504-SR675 provide additional clear evidence of procurement and transportation of chert resources to higher and lower elevations. The twenty Ojc artifacts found on top of Mk strata at 23SR775 is proof of the movement of Ojc chert upslope to higher levels — the summit of a small ridge in this case, whereas, the presence of several Mk flakes at 23SR773 and 23SR774 is a clear indication of movement of Mk chert downslope onto the Ojc formation.

23BT27

23BT27 ARTIFACTUAL ANALYSIS (UTILIZATION)

One archeological site designated 23BT27 was found during the survey of Pennsylvanian strata in Bates County. All of the artifacts on the surface of 23BT27 were collected to determine what chert types were utilized by prehistoric inhabitants of this site located on the virtually chertless Pck Pennsylvania strata. A total of 103 artifacts were recovered from the site. The majority of these artifacts, seventy-three or 70.9%, were identified as made from Mo chert; nine or 8.7% were made from Mk chert; eight or 7.8% were identified as Ojc chert; and thirteen or 12.6% were unidentified as to type of chert, probably representative of chert exotic to the Truman Reservoir area.

According to the Geologic Map of Missouri (Anderson, et al. 1979), the nearest chert-bearing strata to 23BT27 are outcrops of the Mo formation 8 km and 13 km downstream to the southeast and the Mk formation 10 km and 15 km downstream to the southeast on the Osage River and Clear Creek, respectively. In addition, the Ojc formation is available 15 km southeast on both the Osage River and Clear Creek, and the Mm formation outcrops at least 15 km south along Clear Creek. Thus, since all of the nearest chert-bearing strata exists downstream to the southeast of the site in the Truman Reservoir area, none of the above Truman chert types would have been locally available at 23BT27 even as redeposited stream bed chert.

The fact that 87.4% of the artifacts collected from 23BT27 were made from Mississippian and Ordovician chert resources located at a distance of at least 8-15 km downstream in the Truman Reservoir area indicates procurement and transportation of these Truman lithic resources to this essentially chertless area several kilometers to the northwest by either trade networks, direct procurement, or seasonal wanderings. However, the presence of thirteen unidentifiable

or exotic chert-artifacts found at 23BT27 probably indicates procurement and transportation of materials from Pennsylvanian chert-bearing strata far to the northwest of 23BT27. The closest chert source would probably be the Kansas City Group strata about 60 km northwest but upstream on the Osage River.

SUMMARY AND CONCLUSIONS

This has been an integrated study of the availability and utilization of chert resources in the Truman Reservoir area in southwest Missouri with a problem-oriented design to determine utilization patterns of the available chert resources. There are six different types of chert available in the Truman Reservoir area, however, only the Jefferson City, Chouteau, and Burlington cherts, which occur directly within the reservoir boundaries, were utilized to any great extent by aboriginal peoples. The variable-colored Jefferson City chert is basically non-fossiliferous and may occur in oolitic, mottled, or banded varieties; Chouteau is generally a mottled light and dark grey fossiliferous chert containing predominantly small crinoids and bryozoa; and Burlington chert is light-colored and highly fossiliferous, containing predominantly abundant, large crinoids. Overall, the Jefferson City chert is a finer-grained, better consolidated, better quality material than either Chouteau or Burlington chert; however, the Chouteau and Burlington cherts can locally occur as good a quality material as any Jefferson City chert. Even though these three cherts can have variable and sometimes similar attributes, each can usually be distinguished macroscopically by the trained or experienced eye.

Although at times modified by certain limiting or conditioning environmental factors, each of these Truman cherts are manifested in three different types of natural sources: (1) in situ bedrock outcroppings, (2) residual chert deposits, and (3) stream redeposits. Although bedrock outcroppings provide the freshest unweathered chert, it is not thought to have been a major chert source exploited in the Truman Reservoir due to limited outcrop exposures and laborious mining or quarrying techniques required to procure the embedded chert. Residual chert deposits are usually the best sources of chert in the reservoir; these "free" nodules often occur in large quantities on most hillslopes and may be procured directly from the ground surface with the least amount of effort. Less weathered, better quality subsurface residuum may be quarried from shallow pits that extend below the frostline. Although redeposited stream bed chert found in gravel bars can be procured with minimal effort and its supply is continually replenished, it is generally less desirable than residual chert because in addition to pre-existing flaws and fractures the majority of stream bed chert has

been more extensively weathered due to freezing and thawing and fluvial corrasion and corrosion. Still, stream redeposits were undoubtedly heavily relied upon at times and at all times they probably provided a good supplemental chert source.

Another (cultural) chert source potentially available to prehistoric peoples due to cultural activity was non-local or exotic chert derived from long distance or seasonal travel or extensive trade networks. Local and non-local or exotic chert-artifacts, which may have been procured directly or indirectly, have different depositional patterns. Locally procured and utilized chert-artifacts should be represented archeologically by a higher ratio of decortication, primary, and secondary flakes and debris than tools. On the other hand, non-local and exotic procured and utilized chert-artifacts should be represented by a higher ratio of tools than flakes and debris, and in the small amount of debris that does exist, there should be a high percentage of tertiary (finishing or maintenance) flakes.

An economizing (or availability-utilization) hypothesis was presented in which it was postulated that procurement and utilization of chert will be directly related or proportional to the availability of and proximity to particular chert resources. However, it was recognized that various environmental, cultural, technological, and functional factors may have affected the procurement and utilization of the available chert resources.

An intensive Chert Survey program was developed and implemented to determine the availability, distribution, quality, quantity, and accessibility of the different types of chert and chert sources at several locations throughout the reservoir and to procure chert samples from these different chert resources to curate for comparative purposes. It was decided to concentrate on surveying, sampling, and assessing the chert resources within a 1 km radius circle or territory centered on ten selected sites within which it was posited the greatest quantity of lithic resources would be obtained. Based on the Chert Survey of each territory, predictions were made on the percentage of each type of chert that was expected to occur in the selected sites' artifact collections.

The chert surveys of the ten 1 km radius territories determined the quality, quantity, and distribution of the locally available chert resources, revealed the variability in the types of cherts that exist in different areas of the reservoir, and provided samples from the different chert types and chert sources for comparative purposes with one another and with actual artifacts from the selected sites' collections.

The evidence obtained from the artifactual analyses of six archeological sites refutes a strict interpretation of the economizing hypothesis that procurement and utilization of chert will be directly proportional to proximity or availability of the chert resources. The analyses suggest the actual utilization pattern is more complex: that both availability-procurement distance and quality are the controlling factors in chert utilization in the Truman Reservoir. In certain territories where all three of the Truman cherts were locally available, there was evidence of a consistent bias in chert use because there was usually a clear or predominant preference for and overrepresentation of one particular type of chert, viz., Jefferson City. This preference for Jefferson City chert is probably due to its generally better flint knapping qualities: it is fine-grained, well-consolidated, and exhibits a smooth conchoidal fracture and glass-like properties.

The economizing hypothesis as stated links chert use directly to the availability of natural resources and does not account for human behavior, specifically, selection among available chert types due to varying knapping qualities. Thus, the proposed economizing hypothesis must be rejected because it does not consider the importance of chert quality as demonstrated at most of the sites analyzed or the curation and transportation of non-local and exotic chert-artifacts via nomadic groups or trade systems as indicated at 23HE9. As a result of these studies, the hypothesis should be modified and revised to: the procurement and utilization of chert resources predominantly depends on the availability and the quality of the chert resources.

The occurrence of a few pieces of non-local and exotic chert-artifacts at a few of the sites indicates some mode of procurement and transportation of these foreign lithic materials into the reservoir area, via trade networks, direct procurement, or seasonal/periodic movements and wide-range wanderings. Although not quantified in each site studied, the artifactual evidence indicates that heat treatment was practiced on all three chert types, and that there was some use of stream deposited or riverine chert. Probably one of the most important ideas this work has demonstrated is that relatively accurate predictions of chert utilization within a particular area can be made after an intensive survey and study of the available chert resources has been conducted.

In a nutshell, then, this study has established that abundant, good quality chert resources are available in the Truman Reservoir area and that prehistorically there was a predominant tendancy to procure and utilize these local lithic resources for flint knapping purposes, depending on availability-proximity and quality.

APPENDIX A

STREAM DEPOSITED CHERT TEST

Introduction

It would be extremely difficult if not impossible to determine the actual utilization of stream deposited chert in surface or excavation artifact collections. This is due to the removal of the diagnostic feature of all alluvial chert nodules, the smooth water-worn surface or exterior, during decortication of chert nodules in the initial stages of lithic reduction. Flakes from the interior of redeposited chert nodules are indistinguishable from those of bedrock or residual chert nodules. Thus, utilization of stream deposited chert may be inferred only relatively from lithic debitage by the scarcity or abundance of water-worn cortex flakes compared to non-water-worn cortex flakes. The purpose of this stream deposited chert test was to determine the availability, quality, and quantity of the redeposited chert, not the utilization of this chert.

Procedure

A test was conducted on stream deposited or secondarily redeposited nodules in a large gravel bar at the confluence of Wolf Creek and Horse Hollow Branch (chert site SR Str 8) (Plate 7a) in territory SR504-SR675 to determine the quality or knappability and the quantity or percentage of each chert type present in a local stream bed. All three major chert types dominant in the reservoir (Ojc, Mk, Mo) outcropped in the area and were represented in the stream deposit. In addition to the predominant chert nodules, quartzose, sandstone, and limestone nodules were present, respectively.

A 5 x 5 m grid was laid out on the gravel bar (Plate 7b) and ten of the twenty-five 1 x 1 m squares were randomly selected for the experiment. An example of the contents of two squares (9 and 16) are presented in Plates 7c and 7d. Each nodule in a square which had a long axis diameter that measured 10 cm or greater (≥ fist-size) and was at least 3 cm thick was tested. These particular measurement requirements were chosen because nodules smaller than these specifications are generally too small to be used as productive cores. Only those nodules visible and readily picked up off the surface of the gravel bar were used – generally only one nodule deep. Any nodule projecting more than halfway into a chosen square was included in that square's inventory.

Each eligible nodule in a selected square was counted and recorded as to size and chert type and then tested for relative quality or knappability by removing a few flakes

from the nodule with a hammerstone. The knappability of each nodule was graded into the following qualities:

A. Very poor (VP) — Unknappable, very poor conchoidal fracture, sandy or grainy, extensive inclusions and/or incipient fractures.

B. Poor (P) — Practically unknappable, undesirable, full of inclusions and/or incipient fractures, no control over flaking.

C. Fair (F) — Knappable but not quality material, some inclusions and/or fracture planes, average, some control over falking.

D. Good (G) — Quality material, very few inclusions and/or incipient fractures, good conchoidal fracture, control over flaking.

E. Excellent (E) — Pure material with no inclusions or fracture planes, fine-grained, choice material (best available), excellent control over flaking.

Analysis

A preliminary analysis of the quality and quantity of the redeposited nodules at chert site SR Str 8 was conducted in the field at the time of the chert survey of SR504-SR675. The chert descriptions on the chert site survey form read as follows:

> All 3 cherts represented: Ojc ~40%, Mk ~30%, Mo ~30%. There are good quality Ojc and Mk chert nodules in the gravel bar, but although the Mk usually occurs in smaller nodules it also has a lower percentage of fractured nodules than Ojc (which is unusual). The Mo is usually weathered and hard, although a couple of fair quality nodules were sampled.

These preliminary quantity and quality predictions made during the Chert Survey in late July were substantiated by the results from this test conducted in early August. As will be revealed below, the quantity prediction of Ojc chert was very close to the actual percentage. The Mk and Mo predictions were less accurate; however, the prediction of Mk chert was made for all the Mk nodules, not excluding nodules less than 10 cm in diameter as was done in the experiment. Thus, many smaller than fist-sized Mk nodules are not represented in the final percentage of total chert nodules. Observations on the quality of each chert type made during the Chert Survey closely approximate the test results.

The analysis of the data obtained from testing stream deposited chert nodules in each of the ten tested squares at

SR Str 8 reveals some interesting information on the quantity and quality of the three chert types present in Wolf Creek's stream bed. All of the Ojc, Mk and Mo nodules tested in each of the ten selected squares are presented according to knapping quality and quantity in Table 24.

The total number of nodules tested ($\geq$ 10 cm long and $\geq$ 3 cm thick) in the ten randomly selected squares was 257, an average of 25.7 nodules per square. The total number of Ojc and Mo nodules present were nearly equal with 49.8% and 47.5% of the grand total, respectively, with Mk nodules scarcely represented with only 2.7%.

However, these figures are slightly misleading in two respects. First, the above figures represent all the nodules present in the ten squares, including unknappable quartzose, sandstone, and limestone nodules as well as chert nodules. Eighty-four percent of all the nodules tested were chert nodules. A re-evaluation of the data excluding unknappable non-chert nodules gives a better representation of the availability and quality of the knappable resources in the intermittent stream. The total number of chert nodules in the ten squares was 217, an average of 21.7 chert nodules per 1 m square. Of the 40 non-chert nodules present, all but one were identified as Ojc, which alters somewhat the percentage of Ojc nodules. The revised figures of the total number of chert nodules in the ten squares reveal Mo as the dominant chert type in the stream with 121 nodules or 55.8% of the total; Ojc reduced somewhat but still showing a respectable 89 chert nodules or 41% of the total; and Mk relatively unchanged with only seven nodules or 03.2% of the total.

Second, the very low percentage of Mk nodules tested in the experiment does not accurately represent the quantity of Mk chert in the stream – only the quantity of Mk nodules that meet the test requirements and are roughly fist-sized or larger ($\geq$ 10 cm in diameter). There were many more smaller than fist-sized Mk nodules in the gravel bar. This was probably due to Chouteau's general susceptibility to weathering which causes it to readily fracture and disintegrate, especially in a redepositional riverine environment.

The numbers and percentages of Ojc, Mk, and Mo nodules from all ten test squares arranged according to knapping quality are presented in Tables 25, 26, and 27. The total chert composite table for the ten test squares is presented in Table 28.

Ojc

Of the 128 total Ojc nodules present in the squares, 89 or 69.5% were chert nodules and the remaining 30.5% were

TABLE 24

Stream Deposited Chert Nodule Data from Ten Randomly Selected Squares

Nodule Type		Very poor	Poor	Fair	Good	Excellent	Total	% of Total
				Nodule Quality				
SQUARE 2	Mo	2	8	4			14	40
	Mk						0	0
	Ojc							
	Chert	1	3	3	3	2	12	
	Quartzose	2	3				5	
	Sandstone	3					3	
	Limestone	1					1	
							21	60
Grand Total							35	100
SQUARE 3	Mo	2	9	2			13	46.4
	Mk			1	1		2	7.2
	Ojc							
	Chert		3	4	3	1	11	
	Quartzose	1	1				2	
							13	46.4
Grand Total							28	100
SQUARE 9	Mo							
	Chert		14	3			17	
	Limestone		1				1	
							18	64.3
	Mk		1				1	3.6
	Ojc							
	Chert		3	3	1		7	
	Sandstone	2					2	
							9	32.1
Grand Total							28	100
SQUARE 11	Mo	1	11	1			13	59.1
	Mk						0	0
	Ojc							
	Chert		3	3	1	2	9	
							9	40.9
Grand Total							22	100
SQUARE 16	Mo	3	3	1			7	31.8
	Mk				2		2	9.1
	Ojc							
	Chert		3	5	1	1	10	
	Quartzose	1	2				3	
							13	59.1
Grand Total							22	100
SQUARE 17	Mo	2	13		1		16	69.6
	Mk						0	0
	Ojc							
	Chert		1		4	1	6	
	Quartzose	1					1	
							7	30.4
Grand Total							23	100
SQUARE 20	Mo	1	11	1			13	56.5
	Mk						0	0
	Ojc							
	Chert	2	4	1	1	1	9	
	Quartzose	1					1	
							10	43.5
Grand Total							23	100

TABLE 24

Stream Deposited Chert Nodule Data from Ten Randomly Selected Squares

	Nodule Type	Very poor	Poor	Fair	Nodule Quality Good	Excellent	Total	% of Total
SQUARE 21	Mo	3	5	1			9	31
	Mk				1		1	3.5
	Ojc							
	Chert		2	2	2	2	8	
	Quartzose	5	1				6	
	Sandstone	4					4	
	Limestone	1					1	
							19	65.5
Grand Total							29	100
SQUARE 22	Mo	3	2	1	2		8	36.4
	Mk						0	0
	Ojc							
	Chert		7	1	1	1	10	
	Quartzose	1					1	
	Sandstone	1					1	
	Limestone	2					2	
							14	63.6
Grand Total							22	100
SQUARE 23	Mo	4	4	3			11	44
	Mk			1			1	4
	Ojc							
	Chert	1	3	3			7	
	Quartzose	1	1				2	
	Sandstone	2					2	
	Limestone	2					2	
							13	52
Grand Total							25	100

TABLE 25

JEFFERSON CITY

Ojc Composite Table for Ten Test Squares

Nodule Quality	No. of Chert Nodules	% of Total No. of Chert Nodules	% of Nodules Knappable/ Unknappable	No. of Quartzose Nodules	No. of Sandstone Nodules	No. of Limestone Nodules
Very poor	4	4.5	40.5 (Unknappable)	13	12	6
Poor	32	36		8		
Fair	25	28	59.5 (Knappable)			
Good	17	19.1				
Excellent	11	12.4				
TOTAL	89	100	100	21	12	6
% of Total No. of Ojc Nodules	69.5			16.4	9.4	4.7

TABLE 26

CHOUTEAU

Mk Composite Table for Ten Test Squares

Nodule Quality	No. of Chert Nodules	% of Total No. of Nodules	% of Nodules Knappable/ Unknappable
Very poor	0	0	14.3 (Unknappable)
Poor	1	14.3	
Fair	2	28.6	85.7 (Knappable)
Good	4	57.1	
Excellent	0	0	
TOTAL	7	100	100

TABLE 27

BURLINGTON

Mo Composite Table for Ten Test Squares

Nodule Quality	No. of Chert Nodules	% of Total No. Chert Nodules	% of Nodules Knappable/ Unknappable	No. of Limestone Nodules
Very poor	21	17.4	83.5 (Unknappable)	1
Poor	80	66.1		
Fair	17	14		
Good	3	2.5	16.5 (Knappable)	
Excellent	0	0		
Total	121	100	100	1
% of Total No. of Mo nodules	99.2			0.8

TABLE 28

Total Chert Composite Table for Ten Test Squares
(84% of all the nodules tested were chert nodules)

Chert Type	Total No. of Chert Nodules	% of Total No. Chert Nodules	Total No. of Non-Chert Nodules	Total No. of Nodules	% of Total No. of Nodules
Mo	121	55.8	1	122	47.5
Mk	7	3.2	0	7	2.7
Ojc	89	41	39	128	49.8
TOTAL	217	100	40	257	100

quartzose, sandstone, and limestone, respectively. It is interesting to note that 59.5% of the Ojc chert nodules tested in the experiment were found to be knappable, i.e., of fair (F), good (G), or excellent (E) quality, and 40.5% of the Ojc nodules were discovered to be unknappable, i.e., of poor (P) or very poor (VP) quality. Although most of the redeposited Ojc nodules were poor quality (36%), a respectable percentage was of fair (28%) and good (19.1%) quality, and a relatively high percentage (12.4%) was excellent quality chert; in fact, Ojc chert was the only chert type to register excellent quality material. Almost none of the Ojc chert was very poor quality (4.5%).

Mk

All seven of the Mk nodules present in the ten squares were chert nodules. It is interesting that although sizeable Mk nodules are scarce in Wolf Creek, a very high 85.7% of those present were knappable with over half (57.1%) rated as good quality material; only 14.3% of the tested Mk nodules were unknappable.

Mo

Of the 122 total Mo nodules present in the squares, all but one were chert. Although Mo nodules were the most abundant in the ten squares, they were also the poorest quality. Only 16.5% of the Mo chert nodules were knappable, while a whopping 83.5% were found to be unknappable – the vast majority (66.1%) were poor quality.

Conclusion

This stream deposited chert source should have provided a viable, usually readily accessible, and virtually inexhaustible supply of chert to prehistoric inhabitants in the SR504-SR675 territory. According to the random sample at SR Str 8, chert is overwhelmingly the predominant rock type present in Wolf Creek – making up 84% of the total number of nodules. However, as this experiment demonstrates, the quality and quantity of the chert varies widely according to type. The data from the test on redeposited chert at SR Str 8 reveal the following conclusions on the quantity and quality of Ojc, Mk, and Mo stream deposited chert nodules in a typical third order stream located in the southwest portion of SR504-SR675 territory.

Jefferson City chert represents by far the most desirable chert type available in this particular alluvial chert source. Jefferson City chert nodules are abundant (41%) in the stream and its percentage of knappable chert is high (60%). It was probably the major type of chert exploited in the local stream deposited sources.

Although the percentage of knappable Mk nodules is very high at SR Str 8, sizeable nodules of Mk chert occur in such negligible quantities that in local stream deposits this chert type was probably minimally exploited.

Although Mo chert accounts for over half (56%) the number of available nodules in Wolf Creek, they are overwhelmingly (83.5%) highly weathered and unknappable. Therefore, Mo chert in local gravel bars was probably only secondarily exploited, but more so than Mk chert.

Thus, it has been demonstrated that Ojc is the best chert type available for flint knapping purposes in Wolf Creek and was probably the major chert exploited in the local stream deposited chert sources with Mo and Mk cherts playing supplemental roles.

It is interesting to note that eight artifacts were found on the gravel bar at SR Str 8. Three Ojc bifaces, four Ojc flakes, and one Mk flake were recovered from the chert site. One biface was found in square #23 and one biface was found in square #14. For whatever it is worth, seven of the eight artifacts were manufactured from Ojc chert.

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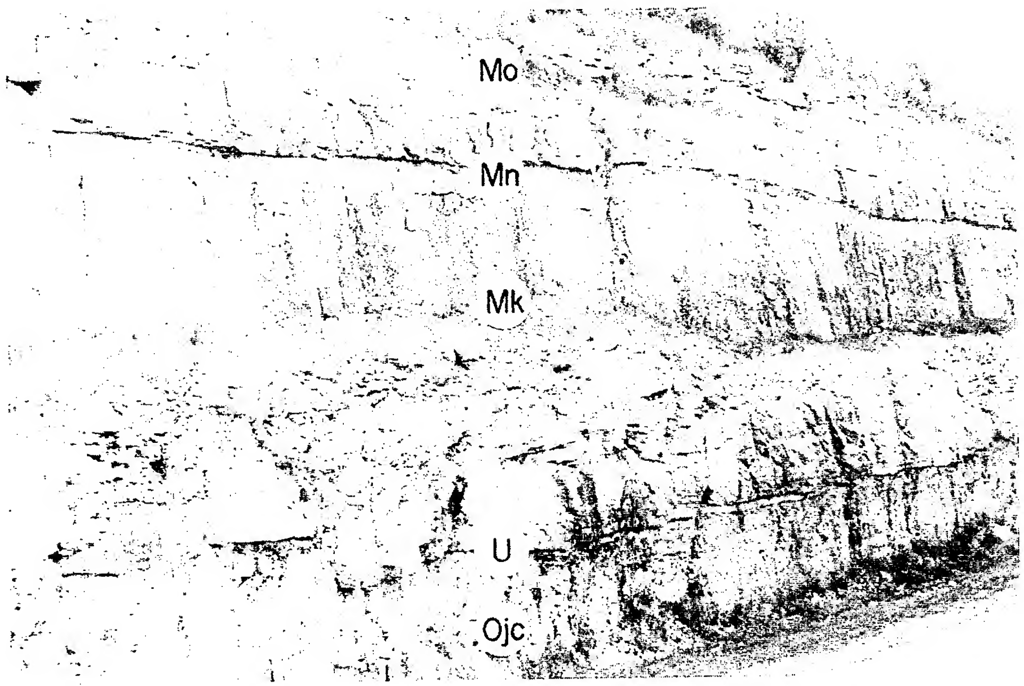

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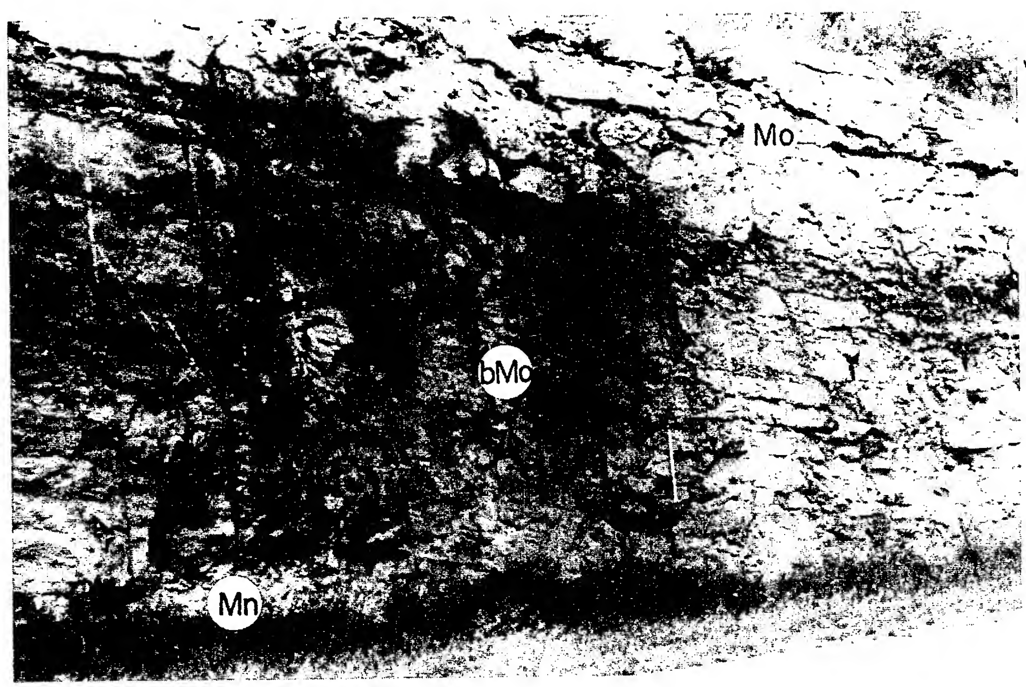


b

Plate 1. a, Stratigraphic relationship of Jefferson City (Ojc), Chouteau (Mk), and Burlington (Mo) formations separated by an unconformity (U) and Northview shale (Mn); b, The "Pierson" formation considered in the Truman Reservoir as "basal Burlington" (bMo).

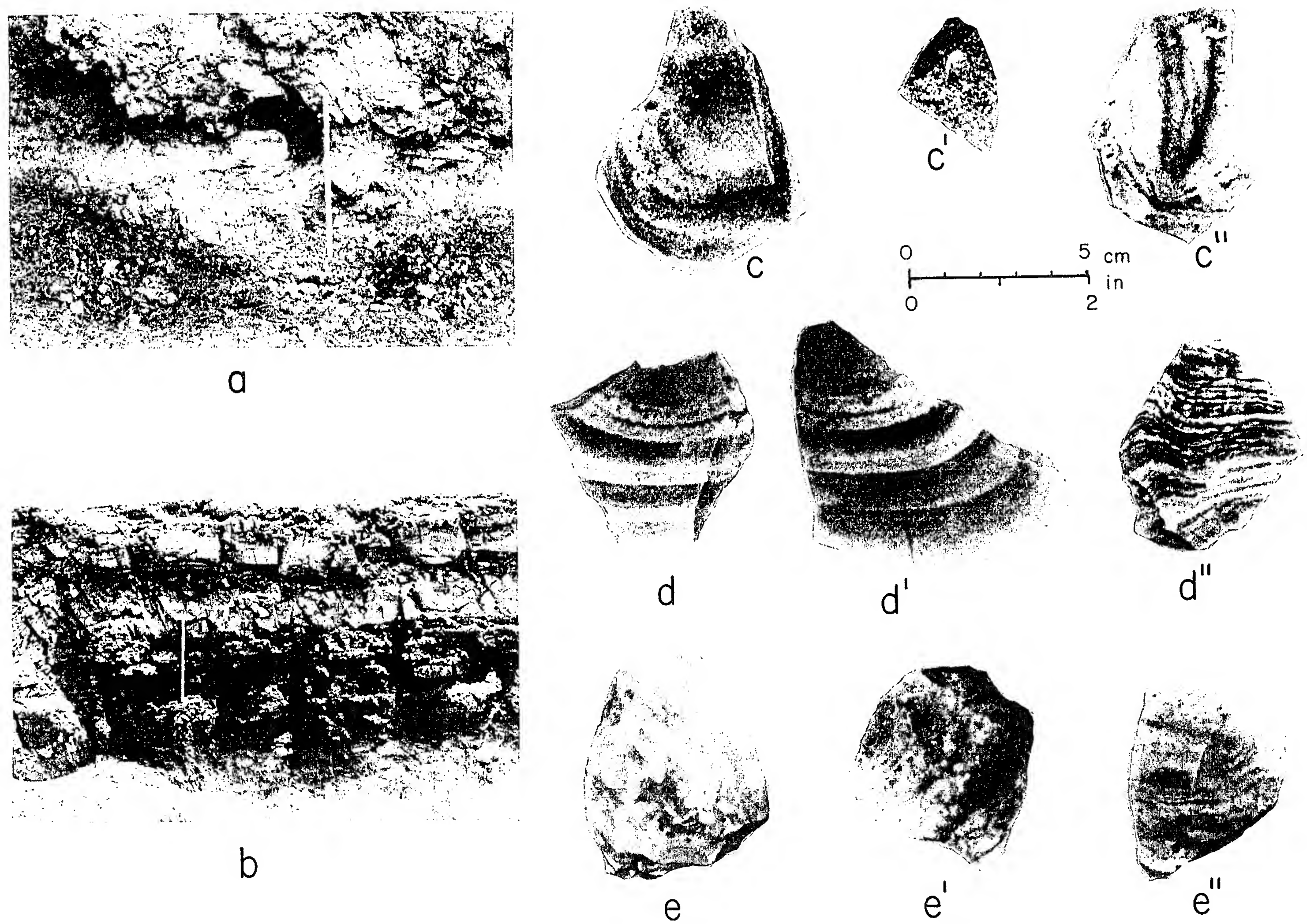


Plate 2. a, Lenticular bed and "free" nodules of Jefferson City chert; b, thin bands of Jefferson City chert; c, oolitic Jefferson City chert; d, banded Jefferson City chert; e, mottled Jefferson City chert.

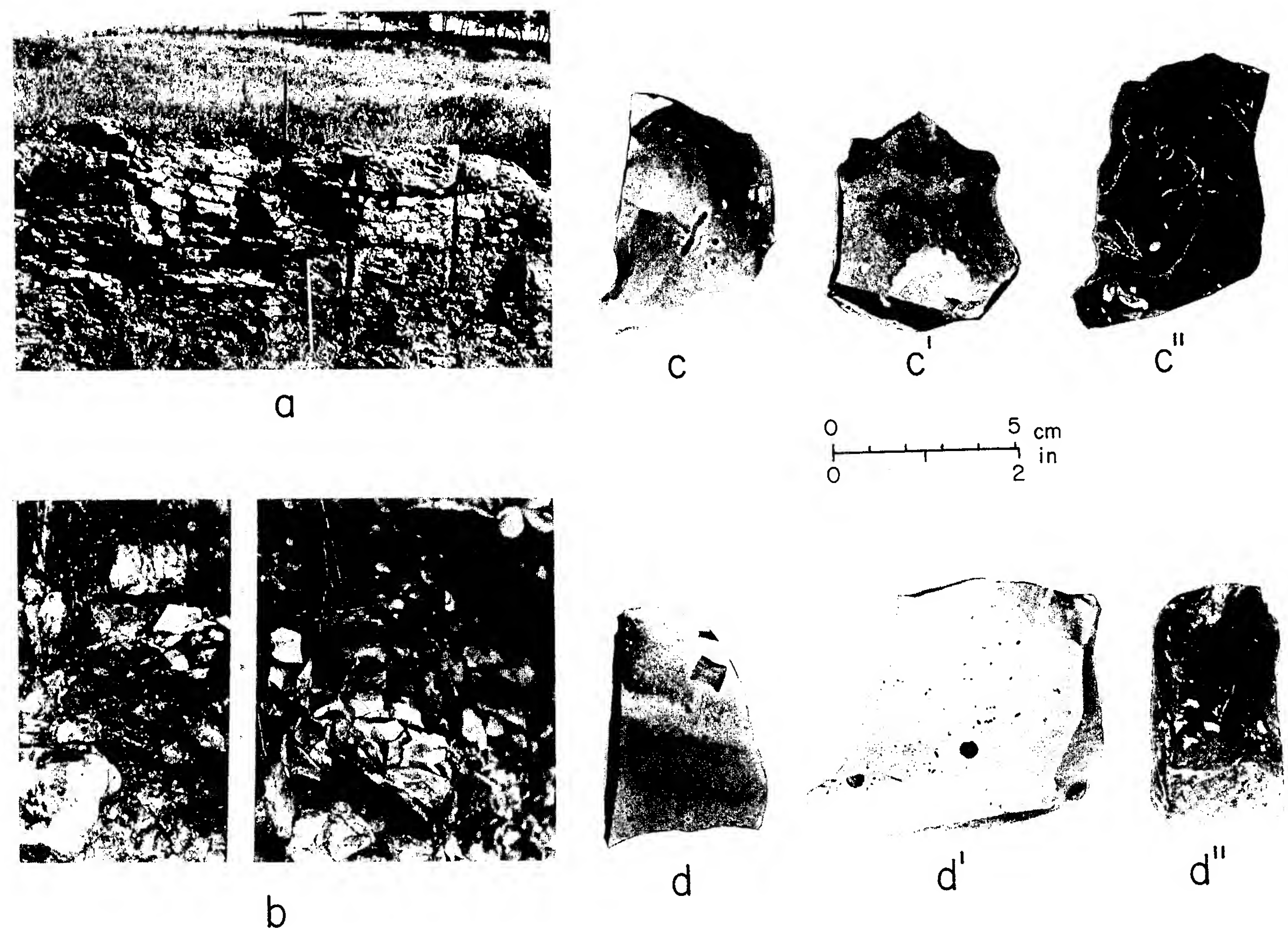
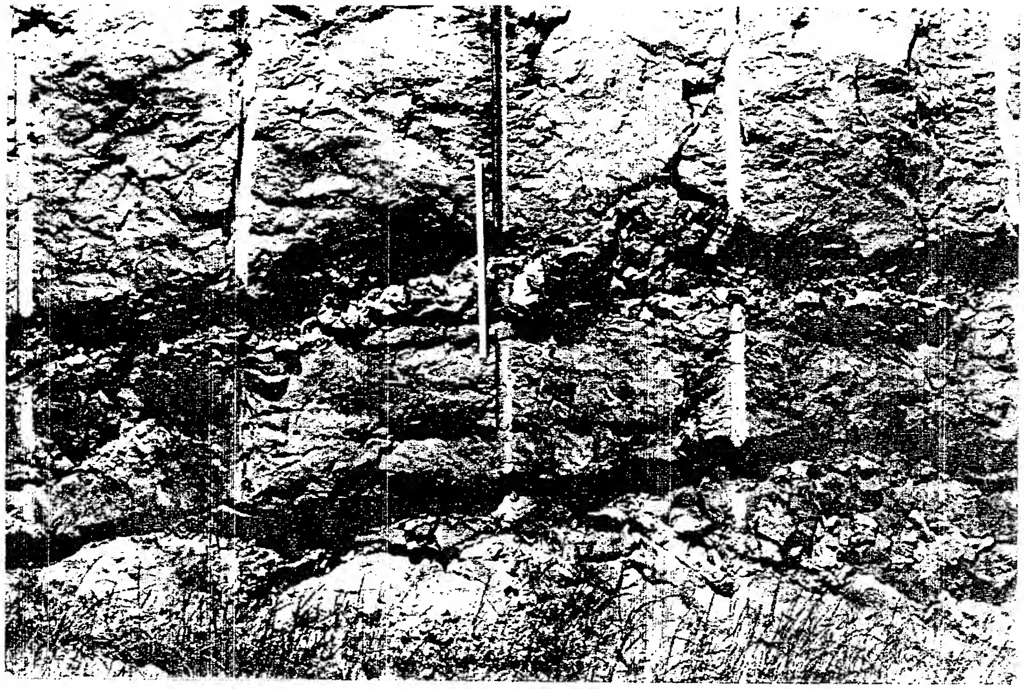


Plate 3. a, Lenticular or tabular nodules of Chouteau chert; b, characteristic blocky, poor quality Chouteau chert due to weathering along incipient fracture planes; c, mottled and fossiliferous Chouteau chert; d, fossiliferous Burlington chert with characteristic crinoids.



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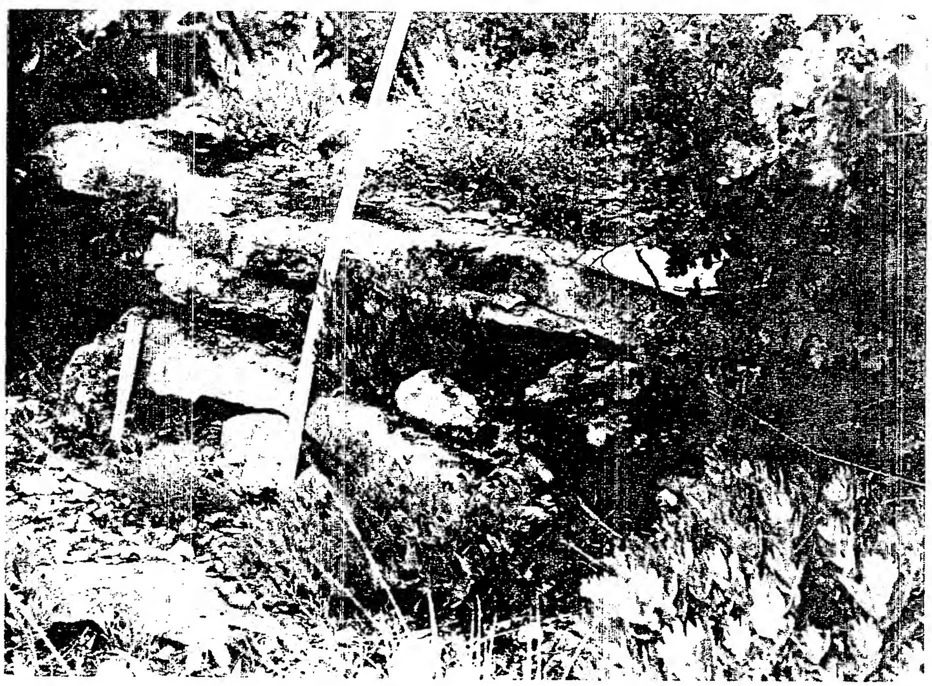

b

Plate 4. a, A seam or continuous layer of Burlington chert; b, an irregular large nodule of Burlington chert.

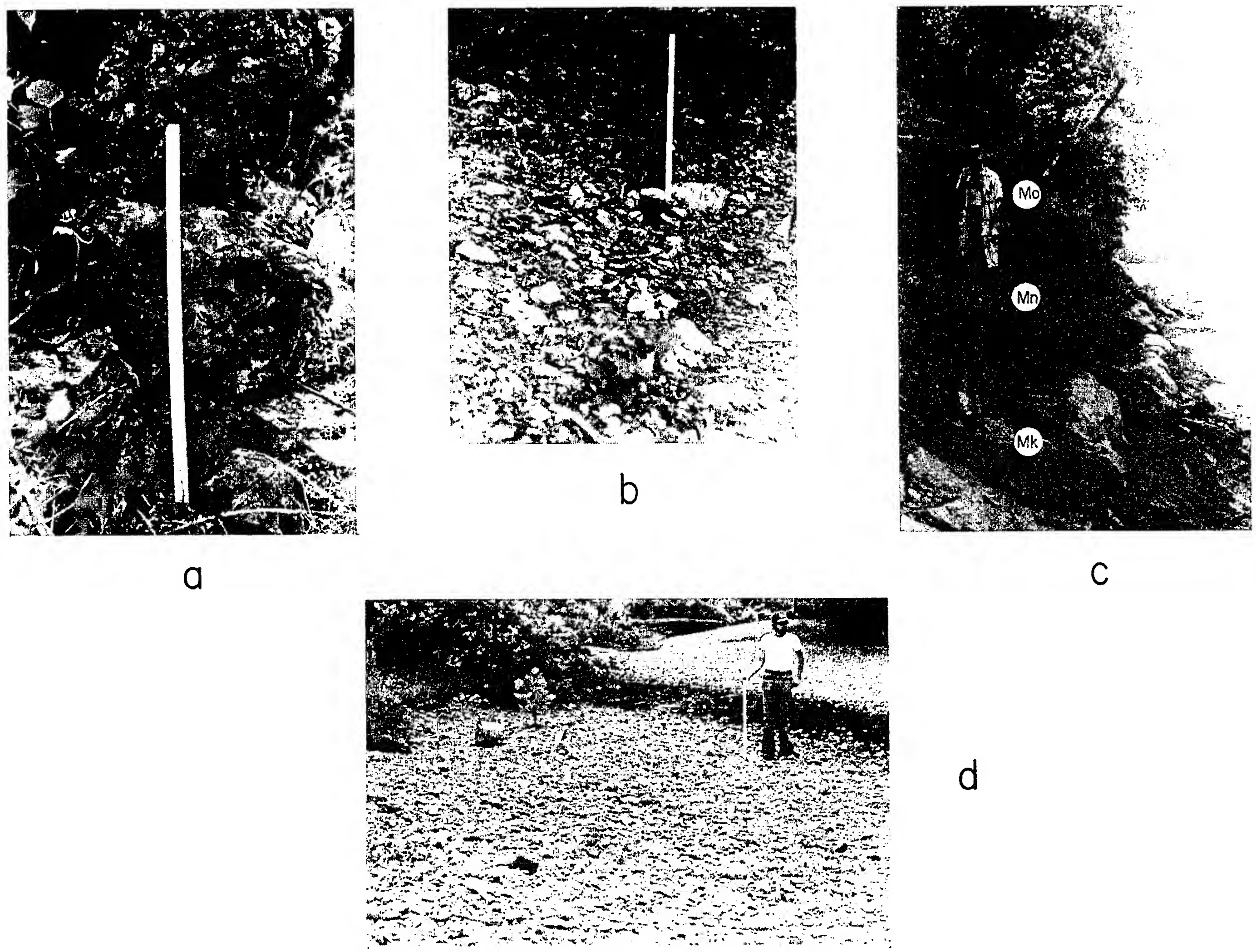

Plate 5. a, In situ bedrock chert (Roubidoux) consolidated in dolomite matrix; b, residual chert nodules (Burlington); c, re-entrant formed by the less resistant Northview shale (Mn) between the Chouteau (Mk) and Burlington (Mo) formations; d, secondarily redeposited chert nodules (Jefferson City) in a stream gravel bar.

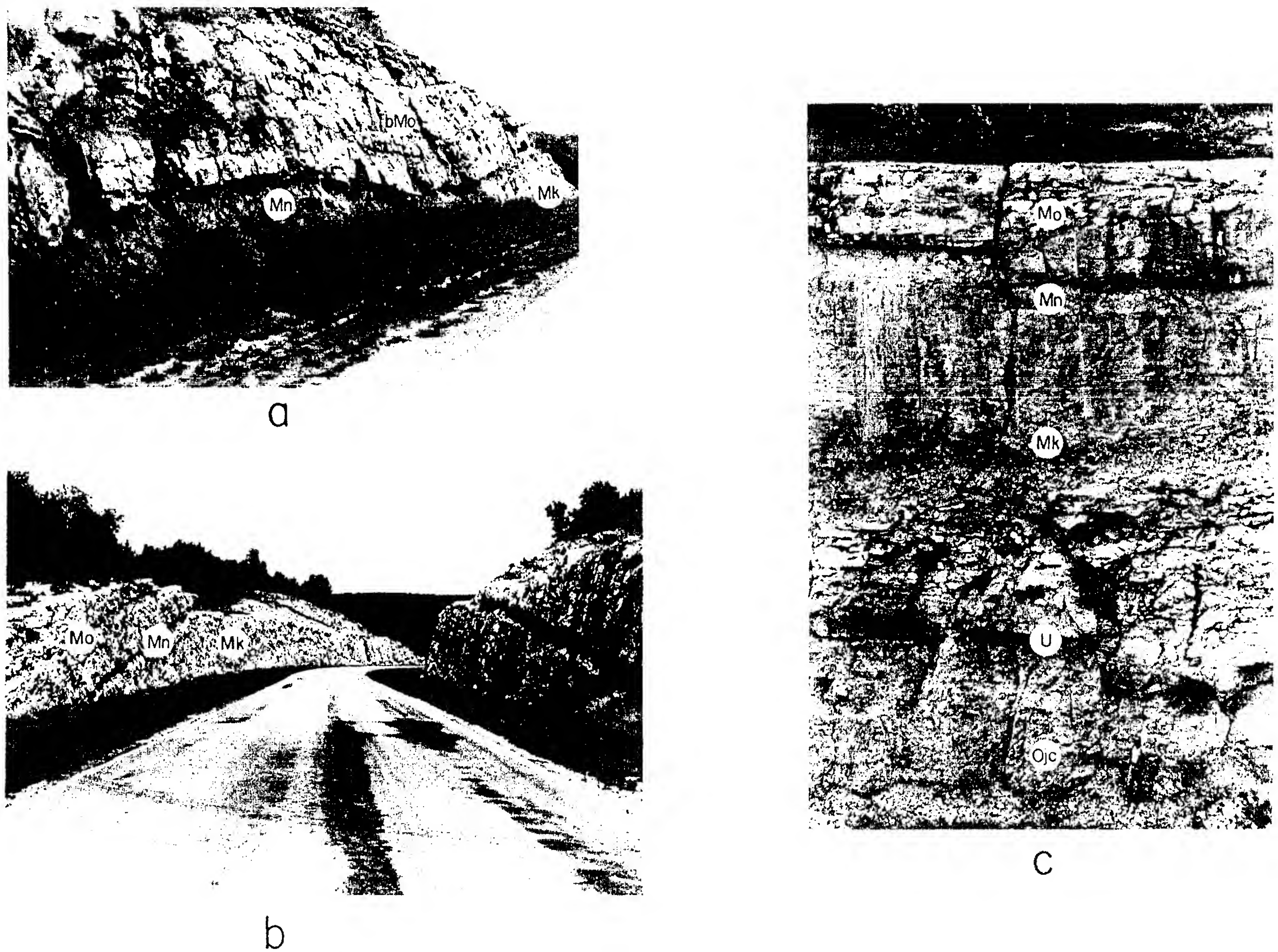

Plate 6. a, Undulating strata within BE337; b, Chouteau (Mk)-Burlington (Mo) contact (separated by Northview shale-Mn) expressed in an anticlinal fold southwest of BE337; c, faulting (approximately 1.2 m displacement) located 5 km southwest of BE337.

a

b

c

d

Plate 7. a, Stream deposited chert nodules at confluence of Wolf Creek and Horse Hollow Branch: the test site (SR Str 8); b, 5 x 5 m grid laid out over large gravel bar; c, redeposited nodules in test square 9; d, redeposited nodules in test square 16.

PART IV.

LITHICS STUDIES

NUMBER 3.

REPLICATING CHIPPED STONE TOOL ASSEMBLAGES FROM THE TRUMAN RESERVOIR

by

Jack H. Ray

ABSTRACT

The tools, raw materials, flint knapping techniques, and procedure or method used to replicate particular chipped stone tool assemblages found in the Harry S. Truman Reservoir are discussed. These chipped stone tools were manufactured from cherts local to the reservoir for functional studies and experimentation in an attempt to contribute to a better understanding of prehistoric tool manufacture and tool functions within the Truman Reservoir area.

INTRODUCTION

Flint knapping, one of the earliest industrial activities of humanity, is the art of systematically producing functional tools out of siliceous materials through controlled flaking processes. Desired flakes are produced by controlling the conchoidal fractures created by forceful blows to, or pressure on, the raw material. Although flint knapping was a major craft of prehistoric peoples for over 2 million years, it became an almost forgotten trade in most parts of the world by the beginning of the 20th century and only recently has it been reconstructed, mostly through ethnographic accounts and experimentation. According to an ethnographic account of the Shoshoni Indians by J. W. Powell in 1875, the manufacture of chipped stone tools was probably a rather specialized prehistoric art being "confined to but few persons who manufacture them and exchange them for other articles" (Lowie 1924: 225).

A flint knapper's performance and the shape and functional performance of the tools produced are governed by four major factors: (1) the skill and experience of the craftsman, (2) the quality of the raw material, (3) the applied techniques, and (4) the type and quality of the knapper's tool kit. Thermal pretreatment of the raw material was an additional factor in at least some prehistoric cultures; this practice and its effects are dealt with elsewhere in this report (Ray, Vol. II, Part IV, No. 4).

PURPOSE

Because the products of flint knapping usually comprise the overwhelming majority of the non-perishable artifacts the archeologist recovers, a basic understanding of these lithic cultural remains (such as how they were made, what they were used for, how long they lasted, etc.) is essential to the interpretation of past lifeways of extinct cultures.

One way of greatly supplementing the information obtained by examination of the physical appearance of artifacts is to do experimental replication (Crabtree 1975: 105-107) to reproduce first-hand, the artifacts and wear patterns found on archaeological specimens. Previous investigators that have performed replicative tool and wear pattern experiments include Semenov (1964), Ahler (1971), Keeley and Newcomber (1977), Newcomber and Keeley (1979), and Odell (1980). Ahler's (1971: 81-87) replicative experiments were for

comparative purposes with stone tools excavated from Rodgers Shelter in the eastern portion of the Truman Reservoir. However, most of the raw material he used was exotic chert to the study area, obtained from Dover, Tennessee.

The major purpose of the present flint knapping experiments was to produce replicas of various types of chipped stone tools found in the Truman Reservoir by this project for use in functional studies and experiments. A total of 243 experimental artifacts comprising 15 functional categories were manufactured from three chert types local to the Truman Reservoir. An example of each functional category is illustrated in Plate 1; the type of chert from which each was manufactured is also listed. For a discussion of butchering, skinning, and other experiments performed with these replicated tools and a subsequent analysis of micro-wear patterns produced on the tools, see Bugby (Vol. II, Pt. IV, No.5).

The following sections deal with the method used to replicate the experimental artifacts. The "tools" used to work the "raw materials" after "procurement" are discussed first. Next is a brief summary of the most common "flint knapping techniques," and last is a detailed account of the actual "method" I used in replicating the artifacts from the raw material to the completed tools.

TOOL KIT

A flint knapper's tool kit consists of those various implements used to manufacture the intended chipped stone artifacts. A basic tool kit usually includes: (1) a hard hammer — preferably a quartzite stone, but any hard, well-consolidated stone will do, (2) a soft hammer of antler, bone, or hard wood called a billet or baton, (3) an antler flaker, (4) a hand pad, and (5) a sandstone abrader (Plate 2a). The tool kit I used to manufacture the replicas for this research was, however, somewhat more elaborate and specialized. It generally included at least three hard hammerstones of different sizes and shapes (Plate 2b). A large (10 cm) cylindrical hammerstone was used to remove the initial large primary blank-flakes from large chert nodules. A medium sized (6 cm), rounded quartzite hammerstone was used to modify the large primary flakes or to produce smaller blank-flakes from smaller cores. The smallest hammerstone (4 cm), usually oblong and quartzitic, was used to trim primary flakes or to remove stubborn projections on flakes too hard for soft hammers.

A soft hammer of elk antler was used extensively during the lithic reduction process to thin and shape large and small flakes into handsome bifaces (Plate 2c). If bifaces were to be reduced further into projectile points, drills,

etc., pressure flakers were employed (Plate 2d). I used two deer antler tines in the final shaping and notching of the biface – a rather blunt-ended tine for shaping the blade and a sharper narrow-pointed tine for producing the notches. A hand pad is a necessity for pressure flaking – the more protection for the palm of the hand the better. I cut two hand-size pieces of leather with thumb holes (Plate 2d) out of an old boot and overlapped them while flaking. Finally, my tool kit contained several abraders (Plate 2d). Two of them were flat pieces of sandstone (one coarse and one fine-grained) used in resharpening the antler flakers. The other abraders had a different shape and function; one was an expended, well-rounded quartzite hammerstone and the others were chunks of sandstone used to abrade the edge of an artifact to strengthen the platform to prevent its crushing.

Although the skill of a flint knapper (Crabtree 1972: 4-5) and the quality of the raw material (Crabtree 1972: 4-5; Semenov 1964: 38-39) are often cited as factors determining superior or inferior workmanship, it is not often recognized that the type and quality of the tool kit plays a part in the quality and shape of the finished products. For example, those peoples with access to a soft metal such as copper may have used copper-tipped flakers to facilitate the pressure flaking process; flint knappers using dulled, blunted hammerstones or billets would have reduced precision in specifying the intended point of impact, controlling accuracy and the thickness of flakes; and regions with absent or limited tool kit resources (such as antlered fauna or hard well-consolidated rounded stones) would be handicapped in flint working activities – flint knappers would be forced to use inferior materials or else import the desired resources.

RAW MATERIALS

After assembling a basic tool kit, the major concern of the flint knapper is to find and procure the best lithic material available, since the quality of the raw material is a major determinant in the outcome of the shape and functional performance of a tool. As Crabtree (1972: 5) has pointed out, "Stone age man was very selective about his raw material, for his very survival depended on his knowledge of suitable stone for implements of specific function." For a discussion of the influence that the quality and inherent properties of raw materials have on stone working, see Semenov (1964: 37-39).

Chert is a dense cryptocrystalline, highly siliceous quartz. There are four main features of this rock that made it attractive to and suitable for prehistoric manufacture of chipped stone tools: elasticity, a smooth but often undulating conchoidal fracture, a hardness of 6.5 to 7 on the

Mohs scale, and an isotropic structure (Hamblin and Howard 1975: 12; Semenov 1964: 33). The isotropic quality of chert means that it has uniform physical properties in all directions and is thus subject to fracture in any direction. The above characteristics make chert a fairly reliable and predictable material to knap.

PROCUREMENT

When selecting chert, the material should be as free as possible of flaws, cracks, and inclusions since these imperfections cause premature breakage and fracture, hindering the flint knapping process. The quality of material has a direct relationship to the applied technique and generally determines the quality of workmanship (Crabtree 1972: 5). Most of the chert procured for flint knapping purposes was good quality material obtained from the local Jefferson City, Chouteau, and Burlington formations.

There were three major natural chert sources potentially available in southwest Missouri that prehistoric peoples could have exploited: (1) in situ natural bedrock outcroppings, (2) residual chert weathered from bedrock, and (3) stream deposits of chert, secondarily redeposited by stream action. Local outcroppings of chert-bearing limestone formations may be found in situ in natural stream cuts (cut banks) or earthslide exposures; residual chert nodules that have eroded free from the bedrock matrix are usually readily available on hillsides, and stream deposits of chert eroded from headwater chert sources (mostly residual) typically choke small intermittent streams.

Although some residual and stream deposited chert was used for present purposes, the majority of the chert procured for experiments was quarried from modern-day roadcuts within the reservoir area. There were very good reasons for procuring roadcut chert. It is the easiest and quickest way to obtain good quality chert in large quantities necessary for flint knapping studies. It is considerably easier and less time consuming to quarry several hundred pounds of exposed chert from a roadcut and load it directly onto a truck than to hike into the field, gather large quantities of chert, and then carry sackful after sackful of heavy rocks back to a vehicle. Each chert nodule quarried was tested for its flaking quality by fracturing it with a hammerstone or rock hammer to reveal its inner texture and homogeneity. Chert damaged from dynamite blasting was strictly avoided. The main exception to the above procurement method was a supply of Chouteau chert obtained from a residual chert deposit located on the top of a ridge. This was one of the few areas in the reservoir that contained a large quantity of good

quality, unfractured Chouteau chert. The residual chert was also tested and then put into burlap sacks and carried to the vehicle on a nearby county road.

FLINT KNAPPING TECHNIQUES

Percussion techniques involve either striking a chert nodule against an anvil stone or, more commonly, striking a chert nodule with a sharp blow with a hammerstone or billet. Crabtree (1972: 7) states that the only requirement is that the percussor be of material different from the stone being worked. However, evidence from the Truman Reservoir (Kay et al. 1978: Chap. 7, 28-38) indicates that chert hammerstones, although probably multipurpose tools, were also used in working the local cherts. This was probably due to the scarcity of quartzite cobbles.

The hand-held direct percussion technique is one in which a chert nodule or artifact is held in the hands and is struck against a stationary anvil stone (Crabtree 1972: 10-11). This technique was not used in my flint knapping experiments because it is a hazardous procedure since detached flakes fly in the direction of the worker (often in the face) and the fingers holding the chert are vulnerable.

Bi-polar percussion involves the placement of the objective piece on an anvil stone and subsequently striking it with a percussor, as one would crack a nut. Since force is induced from both the anvil and percussor, cones of force are produced at opposite ends of the chert piece; bulbar scars are seldom created (Crabtree 1972: 10-11).

The indirect percussion technique requires the use of an intermediate punch, a rod-like tool of stone, bone, antler, or hard wood, which is positioned between the chert and the percussor. This technique gives the knapper more control and allows for more accuracy as the worker is able to place the tip of the punch directly upon the desired percussion spot on the platform of the chert piece and is also able to maintain a constant angle during the percussion. A limiting factor of this technique, however, is the requirement of two people for best results – one to hold the chert stationary and one to hold the punch in place and deliver a blow to the end of the punch with a hammer.

The most common and widely used percussion technique is direct freehand percussion. In this technique, the knapper holds the chert to be flaked in one hand and strikes it directly with a vertical blow from a hard or soft hammer in the other hand. This technique was the predominant style of percussion flaking utilized during my flint knapping experiments. A variation of this direct percussion technique is to support the chert piece on either side of the leg.

The flint working technique that produces the most accurate and controlled flaking, usually used in finishing artifacts, is pressure flaking. This technique involves placing a biface or flake on a hand pad in one hand and with an antler tine in the other hand applying slightly increasing, steady pressure to the edge of the artifact, which will detach small flakes from the underside.

A technique which greatly increases the pressure that can be applied to an artifact is to position the elbows on the inside of the legs and simultaneously apply pressure on the artifact from both the arms and legs. The combined pressure allowed production of much longer and thicker flakes than was possible with just arm and shoulder pressure. This technique also allows for greater control over the flaking.

A variation of the pressure flaking technique involves using a chest or shoulder crutch held by both hands on a nodule; one leans on the crutch applying pressure from the torso and arms. This technique was probably used mostly for removal of blades from prepared cores. Crabtree (1966: 17-22) has also demonstrated its usefulness in fluting lanceolate projectile points.

FLINT KNAPPING METHOD

Prior to or during the reduction sequence, the chert to be worked may be heat treated to improve its knapping quality – especially if it is coarse or poor grade material. None of the chert used to manufacture the 243 experimental artifacts was heat treated since most of it was good quality, fine-grained material to begin with. The process of heat treatment and its effects on the three local cherts are dealt with at length in another section (Ray, Vol. II, Pt. IV, No.4).

The art of flint knapping, or the reduction of a piece of raw material into a finished cultural tool, basically involves three broad sequential steps: (1) hard hammer percussion flaking, (2) soft hammer percussion flaking, and (3) pressure flaking; each of these three processes will be dealt with sequentially. The type of hammerstone material and technique used is determined by the quality of material being worked and the stage of manufacture (Crabtree 1972: 9; 1975: 108). The knowledge of what type of hammer and technique to use on which materials and during which stages comes with experience. The following discussion of flint knapping steps is the method that I have found to be the most efficient and productive in working chert. It is the same method I followed in replicating the tool assemblages used for experimental purposes by Pamela Briney. It should be understood, however, that certain techniques in flint knapping will inevitably vary with different workers and that this procedure is by no means the only one available.

The first step in the reduction process is to reduce a chert nodule into large flat flakes or blanks by striking a quartzite hammerstone or other hard hammer on a flat surface — the "platform" of the nodule (Plate 3a-b). The platform area may be a natural flat surface or a prepared surface. A prepared platform is created by: (1) removing a broad flat flake or flakes, (2) straightening the edge of the platform by removing weak overhangs, or (3) abrading a thin jagged edge down to a rounded surface which strengthens the platform area, preventing crushing.

The width and length of a flake or blade are controlled by the surface area of the material; flat surfaces cause the force to spread, thus producing short, broad flakes, whereas ridges will confine the force and allow long blades to be formed (Crabtree 1972: 12). A flake's thickness is determined by where the force of impact is placed on the platform; force applied near the edge of the platform usually creates thin flakes and force applied further from the edge produces thicker flakes. The straightness of a flake depends on the inertia of the nodule and the line of trajectory. If the nodule is held loosely in the hand and gives with the blow, then the flake will be curved; however, if the nodule is held stationary on the leg or on an anvil, the flake is likely to be straighter. The other factor controlling the straightness of a flake is the line of trajectory of the swing of the hammerstone. An arched blow produces a short curved flake, whereas a straight-on blow produces a longer, thinner, straighter flake. Flakes that do not carry through to the other end of the core terminate in feather, hinge, or step fractures. The trait of flake and blade termination is the result of regularity or irregularity of the material surface and the amount and the angle of force (Crabtree 1972: 12). Research into the intricacies of fracture mechanics is beyond the scope of this report. The interested reader is referred to quantitative studies dealing with fracture mechanics (e.g., Henry, Haynes, and Bradley 1976; Speth 1972, 1974, 1975; Faulkner 1972).

After a chert nodule has been reduced to several large primary flake-blanks (Plate 3c), an antler baton or billet (soft hammer) is used to shape and thin these large flakes by removing secondary flakes from the edges of the blank (Plate 3d). The force of the blow is applied to the platform of the upside part of the artifact, removing flakes from the opposite underside. This step is continued until a relatively thin leaf-shaped biface is produced. According to Crabtree (1972: 9), soft percussors contact larger areas of the platform causing billet flakes to have diffused bulbs of percussion.

The final shaping and finishing touches to most artifacts are made by controlled pressure flaking, producing regular,

uniform, acute edged tools with accuracy and precision. The pressure flaking implements that I used in knapping experiments were two green or fresh deer antler tines (flakers); old weathered antler tines are too soft and do not hold up very well in flaking chert. Pressure flaking accessories include a leather hand pad, an abrader, and a glove to back the flaker if there is to be prolonged flaking. The artifact to be flaked is placed on the leather pad in the palm of the left hand. One edge of the artifact is held secure and in place with the four finger tips. The left hand with the artifact is then placed on the inside of the left thigh. After taking the antler flaker between the thumb and forefinger, it is positioned on a usually abraded or ground, prepared platform on the edge of the artifact (Plate 4a). To thin a biface, small tertiary flakes are removed via applying pressure on the edge of the platform in a simultaneous inward and downward motion. To bevel an artifact, short steep flakes are detached by applying pressure in only a downward direction.

Although pressure applied through the hand, arm, and shoulder is adequate to detach flakes, I have found that by placing my right elbow on the inside of my right thigh (in opposition to the artifact on the inside of my left thigh) and applying pressure from both legs gives additional strength and support to the process (Plate 4b); this technique enables me to detach larger and longer flakes.

Throughout the pressure (and percussion) flaking procedure, preparation of platform is often necessary. This is usually accomplished by removing weak overhangs, thus straightening and strengthening the edge of the platform, and/or by abrading thin jagged edges down to rounded surfaces (Plate 4c) which greatly expands and strengthens the platform area, preventing its crushing. Besides preventing the crushing of the platform and thus the flake, abrading roughens the platform surface so that the flaker will not slip off.

During the pressure flaking process, the tip of the flaker often becomes dulled, scratched, or splintered. This problem is corrected by alternately using a coarse and fine grained sandstone abrader to smooth and resharpen the tip. Continual resharpening of flakers on sandstone abraders usually produces narrow grooves in the sandstone. Incidentally, these grooves, along with those produced by platform preparation abrading, may be mistaken as arrowshaft smoothers (Plate 4d).

The final touch to those biface preforms destined to become projectile points is to notch them. Since my regular flaker used to thin and shape the blade was fairly blunt, I used a sharper, more narrow-pointed tine for producing the

notches. Crabtree (1972: 14) notes that rodent incisor teeth (probably beaver and ground hog) were often used for notching and serrating. The same technique used in general pressure flaking is utilized in notching except the artifact is alternately flaked more frequently on opposite sides of the notch. Usually, no more than two flakes per side are detached before the artifact is turned over.

The foregoing has been basically a technical or methodological approach to replicating prehistoric artifacts for subsequent experimental work. The discussion of an analytical approach and the development of a comprehensive interpretive/ processual framework by which to view lithic technology in archeological and cultural contexts have been dealt with elsewhere (Schiffer 1972: 156-165; Collins 1975: 15-33) and need not be reviewed here.

APPENDIX

BUTCHERING EXPERIMENTS

Introduction

In an attempt to gain a fuller understanding of tool functions, morphological significance, tool lifespans, and use wear that develops on utilized tools, two butchering experiments were conducted during the spring and summer of 1979. An assemblage of replicated artifacts knapped from three different types of chert procured from the Truman Reservoir were utilized in skinning, cutting, and scraping animal carcasses. The first experiment involved butchering two road-killed deer; the second experiment involved skinning a hundred pound pig. Unfortunately, time did not permit a micro-wear analysis of these particular experimental-replicated artifacts. However, these tools are curated at the University of Missouri-Columbia and are available for further study.

Deer Butchering Experiment

The first butchering experiment, which took place in the spring of 1979, involved skinning and butchering two deer road kills provided by Conservation Agent Darrel Billings, Missouri Department of Conservation, Boone County.

Twenty-one replica artifacts reproduced from three major cherts located in the reservoir were used in this experiment. These included four points hafted on short shafts (20 cm) used for cutting (2 made of Jefferson City chert—Ojc; one knapped from Chouteau chert—Mk, and one knapped from Burlington chert—Mo); four chipped stone hand axes (2 Ojc, 2 Mo); four end scrapers (2 Ojc, 1 Mk, 1 Mo); four side scrapers (2 Ojc, 1 Mk, 1 Mo); and nine unmodified sharp flakes (3 Ojc, 3 Mk, 3 Mo).

Unfortunately because of limiting time factors, the intent of this first experiment was more of creating wear patterns on the artifacts and less attention was paid to details such as exactly which anatomical parts the tools were used on, directions of cutting movements, and length of time spent cutting with each implement; only approximations can be given. In addition to the time factor, there were a number of helpers working with different tools at the same time which made detailed note taking impossible.

The points were used for skinning but for only a short period of time, about two to three minutes apiece. The hand

axes were used in skinning and for butchering purposes, cutting through tough difficult parts such as joints and the tail bone. The majority of the skinning, however, was accomplished with the most efficient, sharp unmodified flakes; each flake was utilized for about eight to ten minutes. Both the end scrapers and the side scrapers were used in scraping fat off of the hides - for about three to five minutes apiece.

Pig Skinning Experiment

The second butchering experiment, which took place during the 1979 summer field season, involved skinning a one hundred pound pig purchased from a local farmer. Eight razor-sharp unmodified primary flakes knapped from Jefferson City (3), Chouteau (2), and Burlington (3) chert nodules were utilized in the skinning process.

Fortunately, during this experiment, the control was much better as detailed notes were recorded on the length of time each flake was used and for what purposes. Except for flake Ojc 1, all the artifacts were used solely for skinning the pig, separating the tough hide from the thick fat and muscle tissue. Flake Ojc 1 was used to cut through the tail bone in addition to skinning. Each artifact, except for flake Mo 5, was utilized in the skinning process for exactly seven minutes, an arbitrary time originally delimited by the first flake when it became dull and relatively ineffective. Flake Mo 5 was the last flake to be used and for only four minutes.

Although the control over the artifacts in the two experiments may be less than ideal, neither is the control over archeological specimens. A future micro-wear analysis of these experimental artifacts should be made since the results would contribute to a better understanding of tool functions and tool history.

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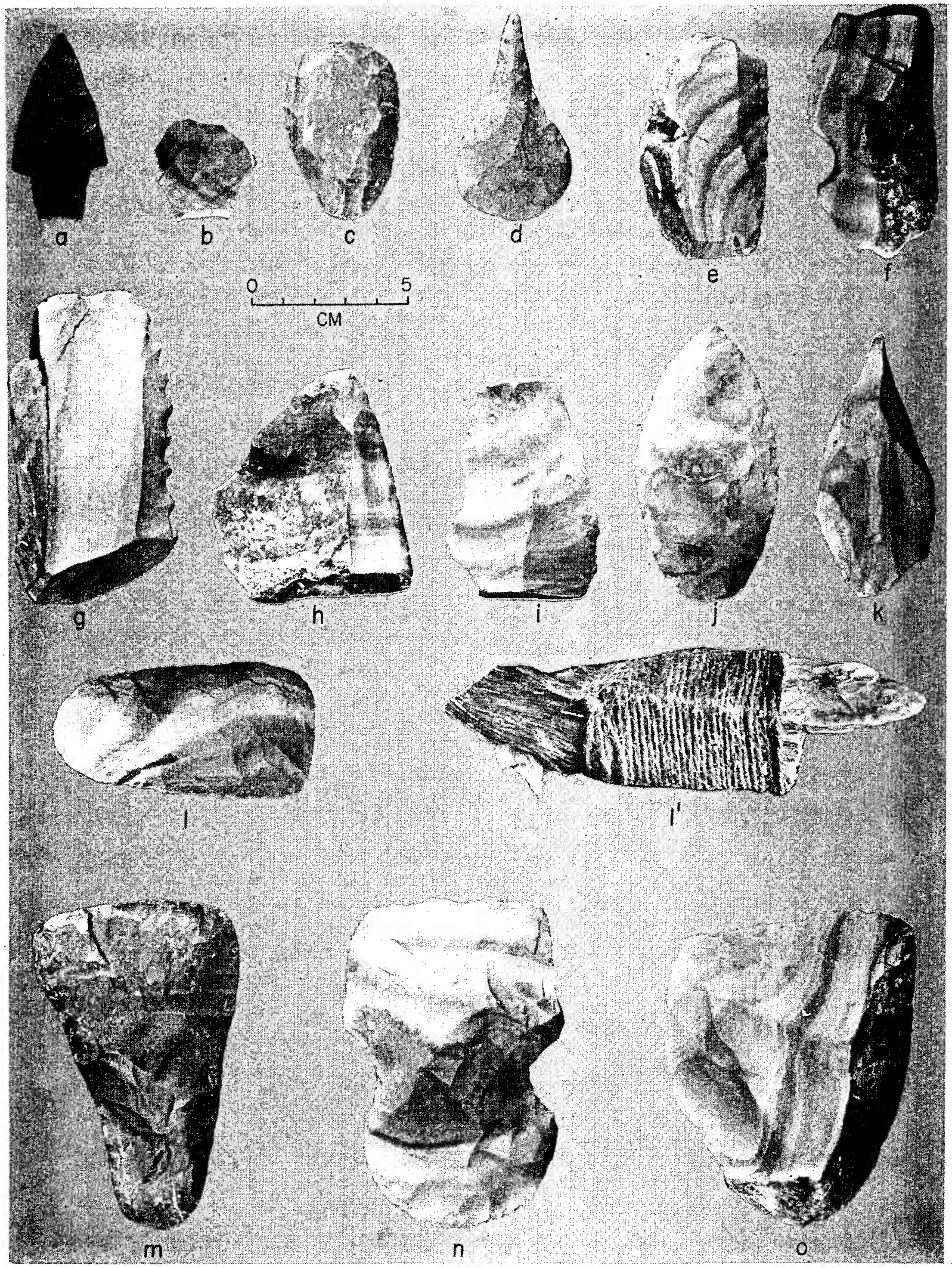

Plate 1. Functional categories of replicated artifacts. a-projectile point; b-graver-burin; c-end scraper; d-drill; e-wedge; f-spokeshave; g-denticulate; h-side scraper; i-unmodified flake; j-biface; k-perforator; l-adze; l'-hafted adze; m-hoe; n-axe; o-cleaver. Artifacts c and m are Chouteau Chert; d and g are Burlington; all others are Jefferson City Chert.

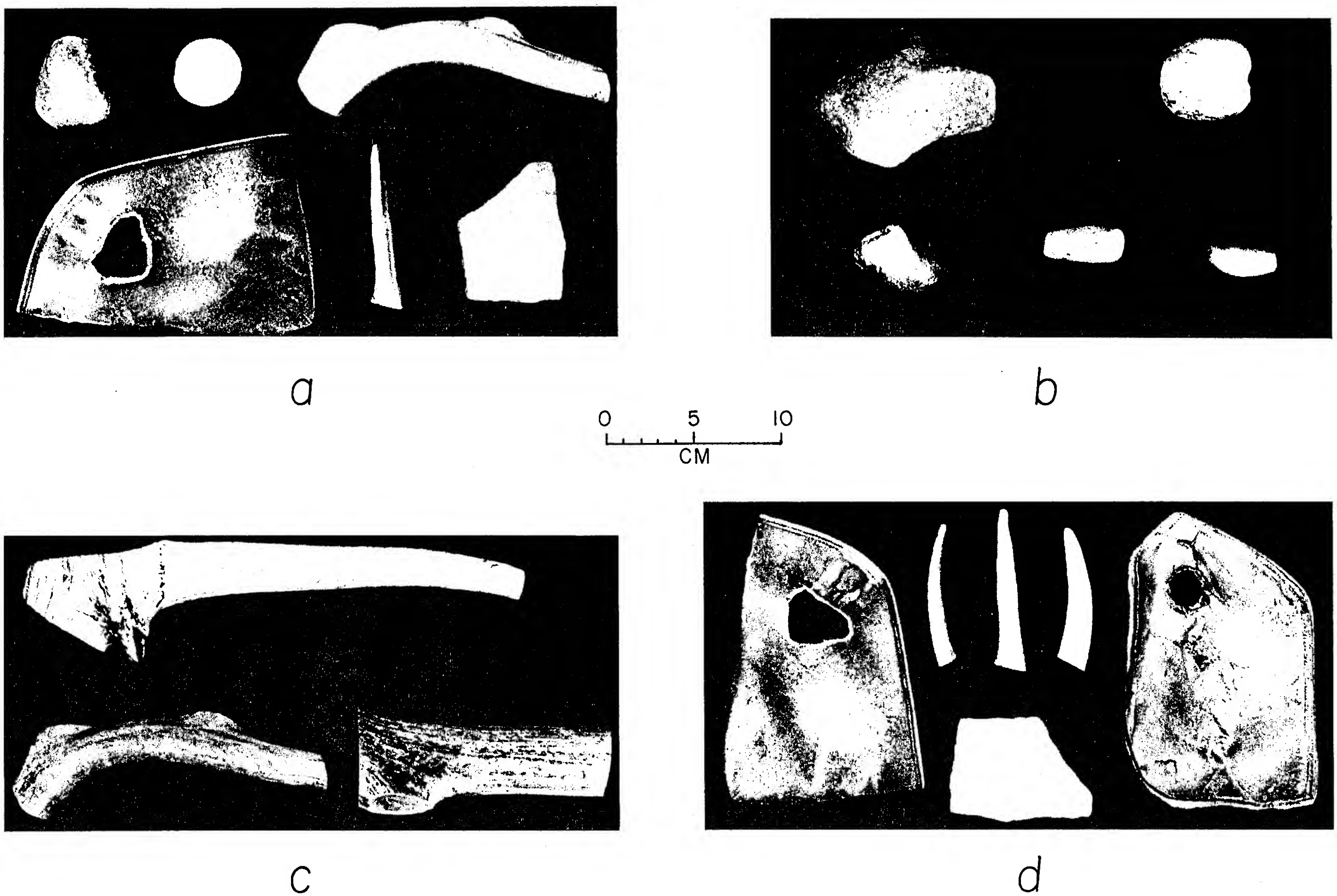

Plate 2. Tool kit - a, basic tool kit; b, hard hammerstones; c, soft hammers; d, pressure flakers, hand pads, sandstone abrader.

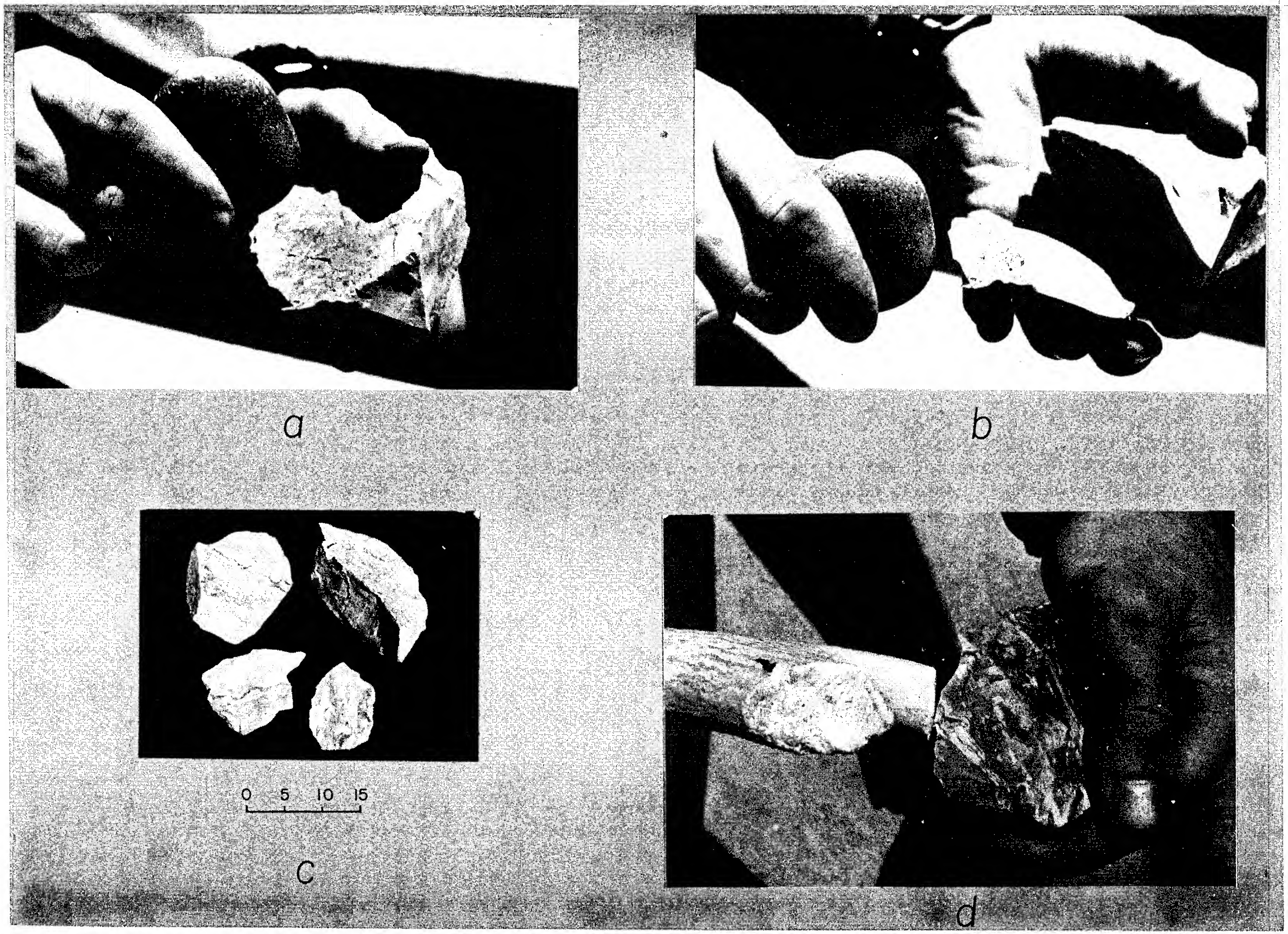

Plate 3. Steps in lithic reduction: a, hard hammer striking platform of nodule; b, resultant flake; c, three primary flake-blanks and core; d, soft hammer percussion flaking.

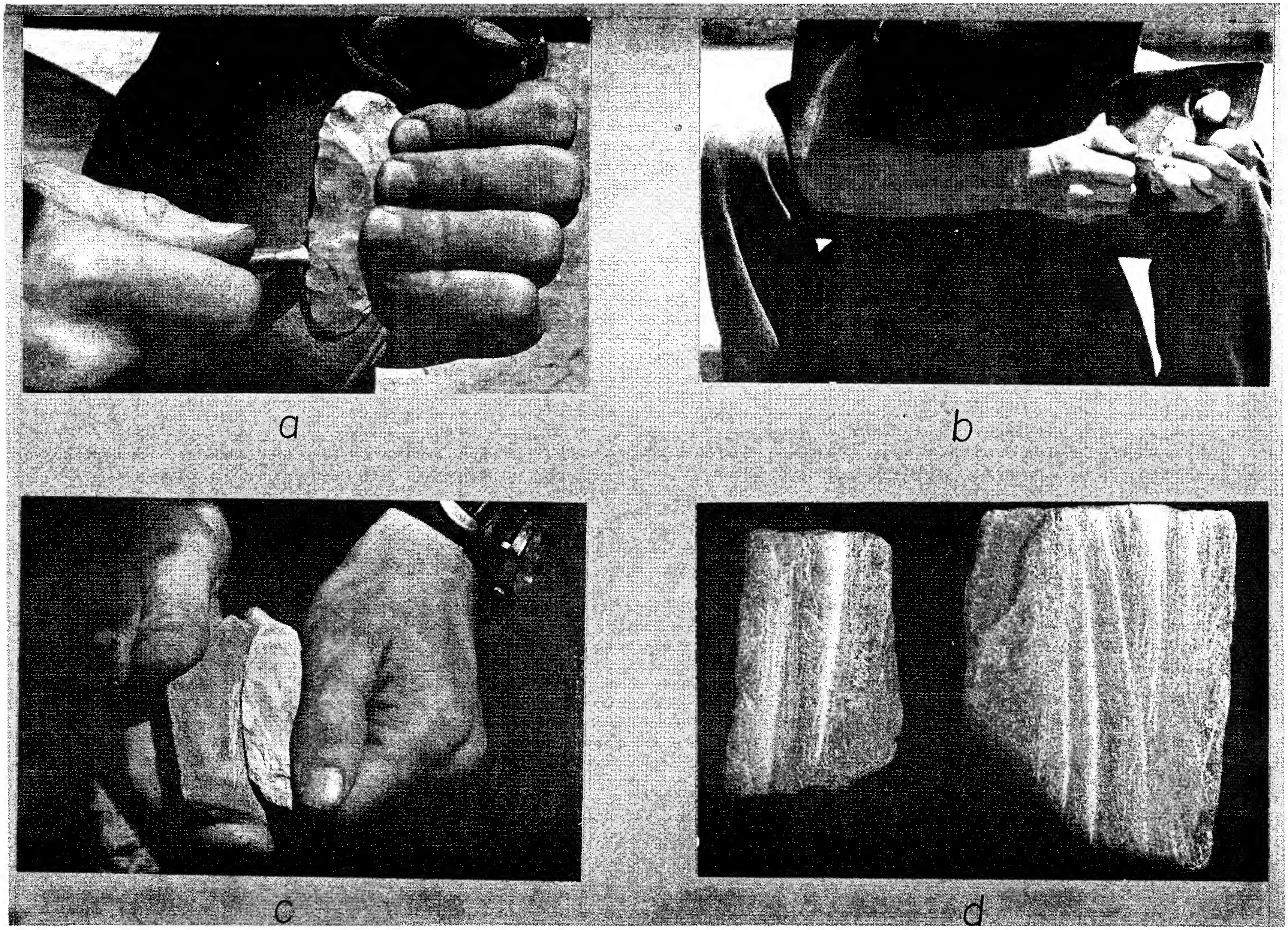

Plate 4. Steps in lithic reduction: a, pressure flaking; b, pressure flaking using added leg support and leverage; c, platform preparation abrading; d, platform preparation abrasion grooves (often mistaken for arrowshaft smoother grooves).

PART IV.

LITHICS STUDIES

NUMBER 4.

THE EFFECTS OF HEAT TREATMENT ON CHERTS FROM THE TRUMAN RESERVOIR

by

Jack H. Ray

ABSTRACT

The effects of heat treatment on visual and internal physical properties of three cherts local to the Harry S. Truman Reservoir are investigated. Three heat treatment experiments were conducted and the results of the thermal alteration of the visual properties are discussed. It is also demonstrated by experiments that resiliency and hardness internal properties of chert change after heat treatment and resemble glassy materials. Results lend support to the idea that heat treatment imparts certain preferable and improved physical properties to chert, causing it to exhibit favorable flint knapping qualities, thus facilitating chipped stone tool manufacture.

ACKNOWLEDGEMENTS

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INTRODUCTION

This study compares the physical properties exhibited by chert in its natural state to those properties exhibited by chert that has been subjected to heat treatment. Three dominant types of chert found in the Truman Reservoir area of southwest Missouri were tested. In my opinion, serious flint knapping studies can hardly be accomplished without a prior knowledge of the literature on the subject or experimentally investigating and determining the physical properties of the particular type(s) of chert the flint knapper is working with.

Ethnographic, archeological, and experimental studies to date present overwhelming evidence that some prehistoric peoples heat treated chert in the tool manufacturing process; this fact is generally accepted today. For good reviews of the ethnographic evidence for the heat treatment of siliceous materials see Hester (1972) and Mandeville (1973).

As reported by Mandeville (1973), Reagan, Rowlett, Garrison et al. (1978), Klippel (1971), Kay et al. (1978), and Collins and Fenwick (1974), archeological evidence of heat treatment has been noted at several well-known prehistoric sites, including Debert, Holcombe Beach, Lindenmeier, Magic Mountain, Shriver, Shoop, Graham Cave, and Rodgers Shelter as well as in the lower Illinois River Valley and Kentucky.

Ever since Crabtree and Butler (1964) published a short account of Crabtree's long and persistent studies on the heat treatment of silica materials, there have been several experiments dealing with this intriguing subject. Until Crabtree's pioneering works (1964; 1966) on thermal pretreatment, most archeologists were reluctant to accept heat treatment as a step in the manufacture of chipped stone tools, mostly because of the associated but unrelated bad connotation of flaking heated chert via drops of water (Ellis 1940).

Today, however, there are at least two major works dealing with the technique of thermal pretreatment and the subsequent effects it has on the microgranular structure and thus fracture behavior of siliceous stones; they are Mandeville (1973) and Purdy (1974). Since these papers have dealt with the microscopic transitions that have taken place within thermally altered chert, this work will focus upon the effects heat treatment has on the physical properties of chert. To date only Goodman (1940), Purdy (1974), and Rick (1978) have

investigated the physical properties of chert as they relate to tool manufacture. Of these three reports, only Purdy and Rick have dealt with heat treated as well as unaltered chert. Both of these chert states will be considered here.

A good knowledge of the variability inherent in particular raw materials in their natural or altered states enables one to make meaningful statements about the formal, functional, and technological variability manifested in chipped stone artifact assemblages (Crabtree 1967: 8-25; Crabtree 1975: 108; Reid 1978: 49). An attempt is made in this study to identify the variability of some visual physical properties of heat treated and raw cherts (such as color, luster, and conchoidal fracture), and also to test two internal physical properties (such as resiliency and hardness) detectable only with the aid of instruments.

PROCUREMENT

The chert tested in this study was obtained from the middle reaches of the Osage River drainage basin in the Harry S. Truman Reservoir in southwest Missouri. Although there are seven types of chert-bearing dolomite and limestone formations within a thirty mile radius of the center of the Truman Reservoir (see Ray, Vol. II, Pt. IV, No. 2), only the Jefferson City, Chouteau, and Burlington formations outcrop in the middle portion of the reservoir where most of the chert for this study was obtained.

The raw material for this study was procured from fresh road cuts in St. Clair and Benton counties; chert damaged by dynamite blasting was strictly avoided. All of the Chouteau and Burlington chert was quarried from four sites along rerouted state highway 82 two to seven miles east of Osceola. The bulk of the Jefferson City chert, however, had to be quarried from a deep road cut one mile west of Warsaw, Missouri because the older Jefferson City formation was at too great a depth in the previous area for the former road cuts to penetrate.

The Jefferson City chert is characterized as commonly occurring in ellipsoidal nodules which often exhibit concentric banding in cross section. The color varies from light to dark: blue, brown, gray, purple, pink, or white. Fossils are scarce in this fine-grained chert although much of it is oolitic (Beveridge 1951: 24). The Chouteau chert is characterized by its light and dark mottled gray core and a prominent white outer cortex. Chouteau chert often exhibits a blocky structure with many incipient fracture planes along which extensive weathering has occurred; thus, it is usually brittle and breaks very easily along these weathered fracture planes. The Burlington limestone produces a better grade of white to light buff and gray chert characterized by diagnostic crinoid fossils that are usually very abundant.

NATURE OF CHERT

Chert or flint is a dense, microcrystalline (or cryptocrystalline) quartz consisting of between 97 and 99% silica (SiO_2), three to one per cent water, and other mineral impurities. The silica is chalcedonic or fibrous in nature (Frondel 1962: 219-21). The formation of chert and flint is still not clearly understood. It is presently thought to be either a silica precipitate deposited in shallow seas (Tarr 1926: 24) or in limestone via ground water (Hamblin and Howard 1975: 47), or a silica replacement of limestone or dolomite during the diagenesis of the rock (Frondel 1962: 222).

In addition to the internal characteristics of chert already mentioned, there are four main features of this rock that made it attractive to and suitable for prehistoric peoples to manufacture chipped stone tools. These are: elasticity, a smooth but often undulating conchoidal fracture, a hardness of 6.5 to 7 on the Mohs scale, and an isotropic structure (Hamblin and Howard 1975: 12; Semenov 1964: 33). The isotropic quality of chert means that it has uniform physical properties in all directions and is thus subject to fracture in any direction. The above four characteristics make chert a fairly reliable and predictable material to knap. It is suggested here that thermal pretreatment enhances or improves these four qualities (from the knapper's view point) inherent in all cherts.

HEAT TREATMENT EXPERIMENTS

Three heat treatment experiments were conducted on Truman Reservoir cherts – one in a small thermally controlled muffle oven and two in hand dug pits, aboriginal style. The second and third experiments were performed in order to understand and approximate as close as possible the native technique of thermal pretreatment. In each heat treatment experiment, alterations of certain visual physical properties such as color, luster, and the nature of the conchoidal fracture are discussed. All natural and heat treated colors would have been coded according to the Munsell Book of Color had there been access to one, but only the Munsell Soil Color Chart was available, which does not cover such colors as blues and purples present in some of the raw and heat treated Truman cherts. Therefore, to be consistent, a more subjective color determination was made by the author outdoors under natural light. However, there is some reference to Munsell color nomenclature (such as hue, value, and chroma) in discussions of other works.

Muffle Oven

The muffle oven was used first. Heat may be applied to chert in different stages of tool manufacture: it may be applied to nodules or cores prior to the reduction process, or to flakes, bifaces, and preforms during the manufacturing sequence. Crabtree and Butler (1964: 2), however, noted that thin pieces of chert (such as flakes and bifaces) tend to survive heat treatment more successfully than thick chunks or nodules due to uneven heating and cooling of large masses, which causes heat fractures. In this experiment, three flakes (two Jefferson City, one Chouteau) and seven bifaces (all Jefferson City) were sandwiched between five layers of sand in a small metal pan. One half of each flake was kept as a control. The pan was then inserted into the oven and the temperature was immediately raisec to 350° C within ten minutes; this temperature was maintained for two hours and then turned off. After one hour, the temperature had dropped to 230° C.

When the chert was removed from the oven and compared to the controls the next day, several thermally induced changes were noted. All of the chert pieces revealed a color change: three Jefferson City pieces turned dark pink, one Jefferson City and one Chouteau piece turned light pink, three Jefferson City bifaces acquired a bleached appearance — especially the darker colors (blues and grays), and two Jefferson City pieces turned light pink or lavendar <u>and</u> exhibited a bleached appearance. When the chert pieces were flaked, the scars displayed a "greasy" or vitreous luster in addition to closely spaced ripple marks. Light to heavy spalling characterized a couple of specimens, and several of the bifaces seemed easier to knap and to produce larger flakes.

Most of the above characteristics exhibited by the muffle oven heat treated samples are well documented in the literature. Reference to more numerous and pronounced ripple marks on flake scars of heated chert was first reported by Klippel (1970: 4) who noted this phenomenon on Burlington chert artifacts from northeast Missouri. This trait was also mentioned by Collins and Fenwick (1974: 138) and Rick (1978: 51) has recently reported its occurrence on heated Burlington chert from western Illinois. This characteristic is certainly not universal but does seem to occur frequently.

A change in the properties of heated chert that causes an improvement in the working quality of the stone allowing greater ease and control over flaking (Crabtree and Butler 1964: 1; Crabtree 1966: 17) is well known to those flint knappers familiar with annealed chert. Crabtree (1964: 1) states that in addition to improving the working qualities of silica minerals, properly heat treated artifacts can be pressure flaked with ease.

A change in color of thermally altered chert was noted early by Crabtree (1964: 1) and has subsequently been explained as due to the presence of varying amounts of iron impurities in the chert (Purdy 1974: 46). However, not all thermally induced color changes are toward the red end of the spectrum. Weymouth and Williamson (1951: 573) note that calcination of European flint radically changes the color of the flint from black or grayish-black to white; Rick (1978: 23) noticed that some of his heated specimens became lighter in color (higher value); and several of my heated pieces acquired a bleached appearance.

The greasy, glossy, or vitreous luster on flake scars of heat treated chert, apparent only after the unaltered dull surface has been removed (Crabtree and Butler 1964: 1-2; Purdy 1975: 136), forms the main visual criterion used today to identify heat treated silicous materials since color change can occur at a lower temperature than the significant change resulting in a greater ease in flaking (Purdy 1974: 52). Luster contrast between altered and unaltered flaked surfaces not only provides the most reliable visual evidence that intentional heat treatment was practiced, but at what stage in the reduction process the heating was conducted – via absent or overlapping luster contrasts on the flake scars.

For a comprehensive discussion on the thermally induced changes imparted to heat treated cherts immediately upon heating and after subsequent flaking, see Collins and Fenwick (1974: 135-140); each category is discussed macroscopically and microscopically.

Unfortunately, this experiment was conducted early in the research and the flakes and bifaces were found to be too small to prepare as specimens for the two physical property tests performed later.

First Aboriginal Heat Treatment Experiment

For the first aboriginal heat treatment replication, the method used by Mandeville and Flenniken (1974: 146-47) was basically followed. A small round pit 60 x 65 cm across and 35 cm deep was dug. In the bottom a fire was built and maintained until coals approximately 10 cm deep had accumulated (Plate 1a). These coals were then covered by a 3 cm layer of dirt since sand was unavailable, and a thermocouple installed to record the temperature of the pit (Plate 1b). Twelve chert nodules and twenty-five flakes and bifaces were then arranged on this thin layer of dirt and around the thermocouple (Plate 1c). A second insulating layer of dirt about 10 cm thick was provided to cover the tallest nodules upon which another fire was subsequently built and maintained until it had accumulated a bed of coals about 10 cm deep.

These coals and the pit were then capped with a third 10 cm layer of soil and left overnight (Plate 1d).

Eighteen hours later when the samples were uncovered, the chert and coals were still lukewarm, despite the air temperature being at least freezing since it was snowing when the chert was recovered. All specimens survived the experiment unscathed except one Chouteau nodule whose many incipient fractures were noticeably widened.

Unfortunately, temperature readings in the center of the pit are unknown as the thermocouple malfunctioned during the experiment. However, based on comparisons of the pit chert with the chert heated in the muffle oven, it is estimated that the temperature in the center of the pit reached 250° to 300° C. This lower temperature is suggested because color change, lustrous flake scars, ripple marks, and ease of flaking on the pit chert were less pronounced than those exhibited by the muffle oven chert.

Second Aboriginal Heat Treatment Experiment

The third heat treatment experiment was conducted during the 1979 summer field season in conjunction with an annual pig roast. Seven bifaces (4 Jefferson City chert, 3 Burlington chert) and twenty-one flakes (7 Jefferson City, 7 Chouteau, 7 Burlington) were knapped out and placed in a prepared pit on top of which a large fire was built and two young pigs were cooked.

The bottom of a large pit about 1.5 m long, .75 m wide, and .60 m deep was first covered with 2 cm of sand. The twenty-eight artifacts were laid on top of this sand and subsequently covered with another layer of sand 4-5 cm deep. Unfortunately, a thermocouple was unavailable at the time of this experiment, thus exact temperature readings for the experiment are unknown. However, an idea of the intensity of the fire may be gained when it is known that at least one cord of wood was burned on top of this sand-prepared pit floor for twenty four hours, leaving a pile of ash and coals 40-45 cm deep which readily cooked the pigs overnight. The chert artifacts spent a total of 111 hours in the pit and were subjected to intense heat for at least the first 36 hours. Near the end of the fourth day (91 hours), an attempt was made to recover the artifacts but they were by far too hot to handle. The coals were then stirred and left to cool until the fifth day (111 hours) when they were finally taken out, still hot.

All the artifacts remarkably survived the long and intense heat treatment without damage. Dolomite slabs which lined the walls and a portion of the bottom of the pit for insulation all exploded, broke, and disintegrated during

the first 24 hours. This phenomenon was probably due to two reasons: (1) the porous dolomite rocks contained much more interstitial water than the chert, and (2) they were exposed to direct contact with the fire, whereas the chert was insulated by about 4 cm of sand.

Of the four Jefferson City bifaces heat treated, three were slightly bleached and moderately smoked, the fourth was less so. All of the Burlington bifaces were heavily smoked.

The twenty-one flakes knapped for this experiment were broken in half before inclusion in the fire pit so that one half could be retained for control and comparative purposes. As a general rule, most of the heat treated halves exhibited little color change except for slight bleaching and light to heavy "smoking"; this refers to the brown to gray smoked appearance that often developed on the surface of the bifaces and flakes — mostly only on the up side of the artifact facing the fire. The smoking in this heat treatment experiment may be due to oxidizing magnesium from the Jefferson City dolomite (with a high magnesium, low calcium carbonate content) slabs which lined the pit. Only one Chouteau flake exhibited a faint pink or reddish alteration.

Of the seven Jefferson City flakes, five showed no change in physical appearance, one was smoked, and one was slightly bleached. Four of the seven Chouteau flakes were smoked, two were unchanged, and one exhibited a slight reddish alteration. Of the seven Burlington flakes, three were slightly smoked, three were noticeably smoked, and one remained unchanged.

Although none of the chert pieces in the sand bath spalled or turned pink, an interesting observation was made when a piece of natural Jefferson City chert was found 4 cm below the rim of the pit. The face of this small chert nodule, which had been in direct contact with the fire, was heavily spalled and exhibited a pinkish cast. However, a change in color for this Jefferson City chert cannot be proven since its original color is unknown. The evidence from this experiment seems to indicate the need for an insulating or barrier medium, such as a layer of sand or dirt, between chert artifacts and an intense fire. Both dolomite rocks and natural chert were adversely affected by the direct contact with flames from a hot fire, whereas all of the artifacts within the sand bath emerged from the pit unscathed.

The very little color change exhibited by the heat treated specimens from the two aboriginal style experiments should not be taken to mean that they were not sufficiently heat treated — only that no color change occurred. Kay _et al_. (1978: Chapter 7, pp. 2-9) in heat treatment experiments

with Jefferson City chert from Rodgers Shelter also found very subtle to no changes in color and Kay *et al.* used a kiln which heat treated the specimens from 230° C to 450° C; Rick (1978: 23) reported that 23% of his heat treated Burlington flakes had no red coloration whatsoever; and although Reid (1980: 132) concluded that all four of his Kansas City cherts responded to heat treatment by developing a pink or red chroma, in each case the color change was entirely surficial and could be easily removed by pressure flaking (he also noted that no luster change occurred on any of his experimentally heated cherts).

The poor reliability of color change as an indicator of the improvement of the flaking quality of chert by heat treatment is widely recognized (Mandeville 1973; Purdy 1974; Collins and Fenwick 1974; Rick 1978). There are two reasons for this: (1) color change may occur at lower temperatures than those required for the improvement of flaking quality, and more importantly, (2) color change is dependent upon varying amounts of particular mineral impurities (mostly iron) in the chert. If there are no iron particles in the chert to be oxidized to begin with, then there will be no color change.

The following is a review of some research on heat-altered chert and some precautionary notes that are pertinent to this discussion of the effects of heat treatment on visual physical properties of Truman cherts.

John W. Rick (1978) performed a number of heat treatment experiments on Burlington chert from the lower Illinois Valley in an effort to ascertain changes caused by heat alteration of local cherts. On the basis of these tests and subsequent observations, he was able to propose several visible criteria for the identification of heat treated Burlington chert. He suggests that used collectively, it is possible to differentiate between heated and unheated chert with a high probability. Ranked from greatest to least reliable, he lists:

1. Flake scar luster contrasts between unheated and and heat treated chert.
2. High luster, provided that the natural range of variation in the chert is known.
3. Flake scars partially overlying heat-fracture scars.
4. Conchoidal rippling on flake scars.
5. Retouched edge angles of less than 30°.
6. Complete removal of the original flake surface.
7. Red coloration.
8. High color value or lightness.

These visual criteria, in general, conform to those found to identify heat treated Burlington chert from the Truman

Reservoir area. However, I would omit the fifth and sixth criteria. These two criteria are easily obtainable on unheated Truman Burlington chert given certain conditions: a skilled knapper with a good tool kit and fine-grained Burlington chert.

Although the above visual criteria proposed by Rick are useful in identifying heat altered chert, none by themselves are 100% effective. One very expensive and elaborate method of positive determination of whether a piece of chert has ever been heated or not is thermoluminescene analysis (Rowlett, Mandeville, and Zeller 1974; Melcher and Zimmerman 1977). This method can also be used to determine an artifact's age, but it cannot distinguish intentional from unintentional heating.

Some precautionary notes are presented here to warn the heat treatment investigator against concluding that all chert exhibiting heat-altered attributes is the result of intentional alteration of the material for the purposes of improving the knapping quality. Gregg and Grybush (1976: 189-192) summarize ethnographic and archeological evidence for the use of fire in stone quarrying and suggest that some heat treated materials from prehistoric sites may have been altered unintentionally, as a result of quarrying practices. However, the fire (and water) quarrying technique would have been used only to dislodge raw material from in situ bedrock chert sources; readily accessible residual and redeposited chert sources would not have been affected by this technique of quarrying. In addition, chert pieces altered by the fire quarrying technique should exhibit external and internal characteristics common to heat fractured chert, such as potlidding, spalling, and crazing as a result of direct heat, uneven heating, or rapid heating/cooling.

Other possible means of unintentional heat treatment of chert include dumping chert debris into hearths as a means of discard, and heating of chert via intense grassland and "crown" forest fires, which may have been started either naturally or culturally. Sauer (1944), Stewart (1951), Day (1953), and Wedel (1957) have presented evidence for American Indian manipulation of the environment via fire. Again, in both cases, the altered chert should exhibit those above attributes associated with contact with direct fire, except possibly residual chert located just beneath the ground surface. In the case of grassland or forest fires, only surface or near surface residual and exposed in situ bedrock chert sources would be altered – redeposited stream bed chert would not be affected, except fire-altered chert transported downhill via erosion into stream beds.

Although reddish coloration has already been noted as a poor and generally non-reliable indicator of heat treatment, one additional note of caution is forwarded to investigators working in the Truman Reservoir area in regard to natural pinkish or reddish colored chert. As a result of the Chert Survey of 1979, it was confirmed that the most variable-colored Jefferson City chert sometimes occurs in pinkish or reddish hues. Both Burlington and Chouteau cherts also exhibited pinkish hues but much more rarely. Thus, only the use of multiple heat treatment criteria such as reddish color in association with lustrous flake scars, pronounced ripple marks, heat fractures, etc. should be used as visual identification criteria for heat treated artifacts in the Truman Reservoir.

PHYSICAL PROPERTY TESTS

The effects of heat treatment on some visual physical properties of Truman cherts have been discussed above. In this section an attempt is made to test the effects of heat treatment on two additional internal or pervasive physical properties of chert – resiliency and hardness – detectable only with the help of instruments. The resiliency property is a measure of the elastic range of a material or its elasticity, one of the four main qualities of chert that makes it attractive for flint knapping purposes. Since resiliency is directly associated with elasticity, it plays a role in pressure and percussion flaking (Crabtree and Butler 1964: 1; Crabtree 1966: 17). The hardness property, another of the four attractive flint knapping qualities of chert, is a measure of resistence to indentation or penetration and resistence to abrasion or wear. Thus, hardness is an important test because it is directly related to the amount of compressive force needed to pressure flake a particular chert and also because it indicates a chert's ability to withstand use wear. The heat treatment process may improve these two properties of chert (from the viewpoint of the flint knapper), thus causing it to exhibit better flint knapping qualities compared to chert found in its natural state.

Since the chert pieces heat treated in the muffle oven were too small to prepare as specimens for the following physical property tests and since the third heat treatment experiment was performed six months after the physical property tests were conducted, only chert taken from the second heat treatment experiment was prepared as sample-specimens for the following physical property tests.

Because chert is a sedimentary rock, its physical characteristics vary greatly even though the basic components, the minute quartz crystals, are uniform in character (Purdy 1975: 134). According to Purdy, the factors that determine

the physical properties of chert are: the size of the quartz crystals, the compactness of the anhedral crystals, the amount of foreign material, fossil replacements, and other heterogeneities present, void spaces, and the crystalline fabric. Measurements of resiliency and hardness of the three chert types in their natural and thermally altered conditions should shed some light on these factors, revealing clear distinctions between the chert's two states.

As mentioned earlier, three different chert types were tested in these experiments (Jefferson City, Chouteau, and Burlington). Samples of an extrusive igneous ignimbrite rock (welded tuff) from southeast Idaho were also tested for changes in the above physical properties for control and comparative purposes. However, the ignimbrite was not annealed since this glassy rock is readily workable in its natural state and needs no further alteration. Experiments have shown that heat treatment has little or no effect on obsidian and other glassy materials (Collins and Fenwick 1974: 136).

The choice of tests was limited by the testing apparatus available at the University of Missouri-Columbia and thus restricted the present investigation to only the following two physical property tests. For a more complete account of the effects of heat treatment on internal physical properties, it is recommended that further work be conducted on Truman cherts in related areas, such as tests for compressive strength, point tensile strength, transverse rupture (bending) strength, impact tenacity, X-ray diffraction, density, and porosity. A summary of the data obtained from the resiliency and hardness tests is presented in Tables 1 and 2. For each material, the range of values and the arithmetical mean of the values is given for the appropriate test.

Resiliency

Resiliency, or rebounding ability, is a measure of the capacity of a material to absorb energy in the elastic range, i.e., without plastic deformation. The resiliency of the chert samples was measured by a Shore Scleroscope, a device in which a small hammer falls from a certain height upon a smooth flat surface of the specimen. The height of rebound of the hammer records the measurement.

Resiliency is directly related to elasticity, a quality which plays a large part in both pressure and percussion flaking. Crabtree (1964: 1) claims that chert in its native state "is tough, relatively inelastic, and will not withstand the necessary pressure, while the latter (heat treated chert) has greater elasticity and will respond nicely to pressure." Resiliency also plays a role in the interval of contact between a percussor and the chert, which is thought to determine the size of a flake.

In order to proceed with this test and the following hardness test, specially prepared samples with two parallel, smooth, flat surfaces were required. Three samples of each type of raw chert, two heat treated samples of each chert, and two samples of ignimbrite were prepared through the use of an automatic diamond studded slab saw. The specimens were then taken to the scleroscope and subjected to five tests apiece.

The ranges and means of the resiliency measurements for the raw and annealed cherts are presented in Table 1. The ranges in general are large, however, other experimenters have obtained similar results. For example, Goodman (1940: 426) notes this peculiarity in her research as well as in tests for the resiliency of cherts measured by the Bureau of Public Roads (cited in Goodman 1940: 426); neither could offer a satisfactory explanation for this phenomenon.

A clear distinction can be made between the thermally altered and unaltered chert samples. In each chert type a higher mean resiliency of from seven (Burlington) to thirteen (Chouteau) points was obtained for the heat treated samples. The ignimbrite had a narrower range of readings (probably indicative of its relative homogeneity) and an average higher than Chouteau and Jefferson City but about equal to Burlington.

These results may be interpreted to indicate that the heat treatment process causes chert to become more homogeneous in microcrystalline structure (Purdy 1974: 49, 51) which in turn causes the chert to increase in resiliency and elasticity; this is well illustrated by the Scleroscope tests. The Shore Scleroscope is a point test which on relatively inhomogeneous material such as raw chert records large ranges in resiliency readings. The heat treatment increased the cherts microcrystalline homogeneity which was reflected similtaneously in the decreased ranges of resiliency and increased mean resiliency (or elasticity). This implies that the elastic limit of chert is extended, which improves the flaking quality of chert by allowing flakes to "bend," increasing the worker's control over pressure flaking and fluting (Crabtree 1964: 1; 1966: 17).

Hardness

The commonly used test for hardness, the Mohs' scale, could not be used here because it is too general; the scale only reads from 1 - 10 and virtually all quartz materials have a Mohs' hardness of between 6.5 and 7. Therefore, the Rockwell Superficial Hardness Tester was used to measure hardness. This machine measured the ability of chert to resist penetration by a diamond tipped cone under a load of

TABLE 1

Resiliency
(Measured by Shore Scleroscope)

Material	No. of Samples	No. of Tests	Range	Mean Resiliency
Mo	3	5	32 - 95	75.77
HT Mo	2	5	62 - 101.5	82.80
Mk	3	5	36 - 93	70.73
HT Mk	2	5	57 - 100.5	83.20
Ojc	3	5	30 - 100.5	72.37
HT Ojc	2	5	63 - 98.5	81.85
Ig	2	5	57 - 87	75.35

Mo = Burlington

Mk = Chouteau

Ojc = Jefferson City

Ig = Ignimbrite

HT = Heat treated

fifteen kilograms. The same seventeen prepared, saw-cut samples used in testing resiliency were required here. Again, each sample was tested five times. An average for each sample was recorded and compiled into means represented in Table 2.

The range of the readings in this test was much more consistent than in the previous one, except for those of ignimbrite and a few heated samples. Ignimbrite proved to be too brittle for the conical diamond point. In 70% of the tests on the ignimbrite samples, an audible crunching or crackling sound was noticed as the 15 kilogram load was increased. This crunching sound was due to the surface material shattering at the point of pressure giving the sample a lower reading than the true values, thus the low 65.21 ignimbrite mean hardness. Goodman (1940: 424) found this type of failure occurred most often on her obsidian samples. Since the upper range limit of the ignimbrite which did not fail is well within the middle range of the chert scores, it may be concluded that though ignimbrite usually shatters easily under pressure, it is probably nearly as hard as chert.

A very interesting development was observed when the heat treated samples were tested for hardness. In each of the three kinds of heat treated cherts, at least two or 20% of the tests revealed the surface failure characteristic of the ignimbrite samples, providing all heat treated cherts with lower mean hardness readings than the raw cherts. None of the chert samples in their raw, native state failed. Therefore, it is probably safe to conclude that some microgranular structural changes occurred in the heat treated chert.

A comparison of Purdy's (1974: 49) compressive strength and point tensile tests may shed some light on the above phenomenon. In the compressive strength tests her heat treated cherts resisted failure longer than the unheated controls, but the results of her point tensile tests revealed a significant reduction in the heated cherts' ability to resist failure. Purdy (1974: 49) explains this seeming paradox in the following way:

> The binding of the microcrystals which occurs when the rock is heated adds compressive strength through cohesion to the structure. The increase in homogeneity which increases strength under compression is the very factor which decreases point tensile strength: (1) the individual microcrystals are bound more firmly together; (2) therefore, when the flaw is introduced which is preliminary to and necessary for fracture

TABLE 2

Hardness
(Measured by Rockwell Superficial Hardness Tester)

Material	No. of Samples	No. of Tests	Range	Mean Hardness
Mo	3	5	85 - 94.7	91.69
HT Mo	2	5	80.3 - 91.9	87.40*1
Mk	3	5	88.7 - 93.3	91.49
HT Mk	2	5	85.9 - 92.2	90.16*2
Ojc	3	5	91.6 - 95.0	93.19
HT Ojc	2	5	83.5 - 94.7	91.20*3
Ig	2	5	47.2 - 90.6	65.21*4

Mo = Burlington

Mk = Chouteau

Ojc = Jefferson City

Ig = Ignimbrite

HT = Heat treated

*1 = crunching audible in 20% of tests

*2 = crunching audible in 30% of tests

*3 = crunching audible in 20% of tests

*4 = crunching audible in 70% of tests

to occur; (3) failure takes place more readily because the specimen fractures more like glass than a rock aggregate.

Rick (1978: 39-43) also conducted a point load strength test on Burlington and Chouteau cherts from the lower Illinois Valley, and he too found a reduction in the tensile strength of his samples after heat treatment.

Tests for compressive and impact tenacity (toughness) were originally intended to be included in this report as one of the physical properties tested for in the cherts. However, facilities at the University of Missouri were not adequate to meet the requirements for preparing ever more elaborate samples that were needed for these tests. Still, I was informed by Dr. Donald Creighton (personal communication), Professor of Mechanical and Aerospace Engineering, that although there is no correlation between hardness and impact tenacity (related to percussion flaking), there is a one to one correlation between hardness and compressive tenacity (related to pressure flaking). Therefore, based on Purdy's compressive and point tensile strength results, unaltered chert in its native state, which does not exhibit the glass-like properties of heat treated chert, should be more difficult to pressure flake.

CONCLUSIONS

It has been stated that the process of heat treatment probably imparts certain preferable and improved physical properties to chert materials, thus causing them to exhibit better flint knapping qualities compared to chert found in its raw native state. The conclusions of Purdy (1974), Mandeville (1973), and Rick (1978) as well as the results obtained here from testing the resiliency and hardness of heat treated chert against those of natural, unaltered chert have tended to support this notion.

Purdy (1974: 51) concluded that thermally altered Florida cherts result in "easier to flake" stones and that this was accomplished by impurities that serve as fluxes, fitting microcrystals closer together after the removal of interstitial water. This alteration process, she says, enables fracture to alternately split and pass through more firmly cemented crystal and intercrystal areas, rather than going around individual grains that occurs in unaltered chert.

Mandeville (1973: 198-99) agrees that mineral impurities in chert serving as fluxes is the key to thermal alteration, but that the melting and fusion take place within a fibrous matrix, transforming the heterogeneous fibrous structure into

one homogeneous mass. Rick's physical tests (especially the fracture test) reveal that heat treatment makes the manufacture of stone tools easier. He also points out that heat treatment not only improves the working quality of chert but that heat-altered and unaltered cherts are differentially useful in different functional contexts (Rick 1978: 62).

Based upon my resiliency and hardness test results, the heat treated chert samples have in fact usually tended to exhibit more knappably favorable physical properties after annealing and to resemble ignimbrite or glassy material characteristics, facilitating chipped stone tool manufacture.

These works then, tend to support the idea that heat treatment of chert was beneficial and advantageous to the potential flint knapper in the quest for the production of more efficient, higher quality, chipped stone tools.

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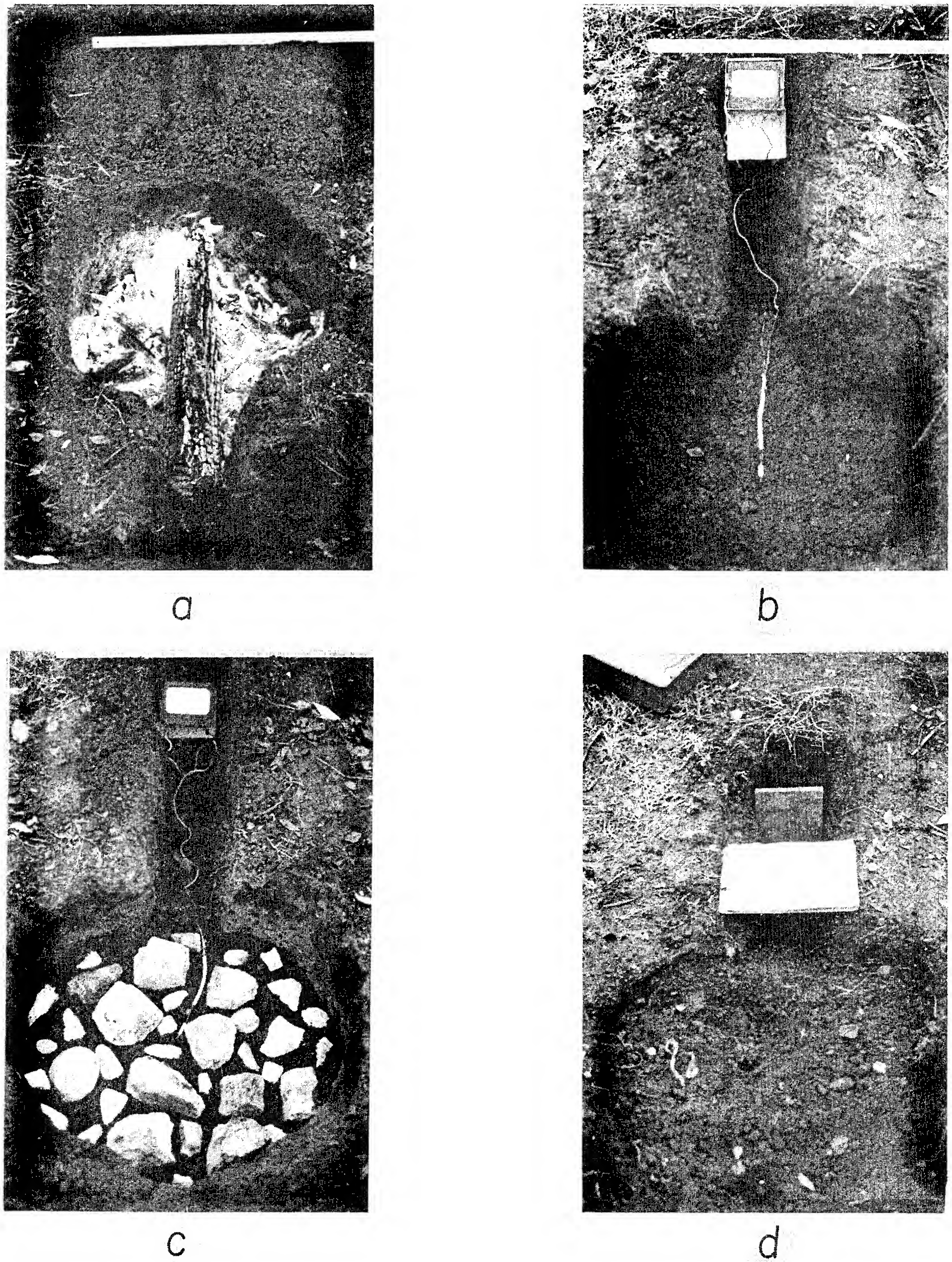

Plate 1. Aboriginal heat treatment experiment — a, initial fire in bottom of heat treatment pit; b, pit after coals were covered with dirt and thermocouple installed; c, chert nodules, flakes, and bifaces arranged in center of pit; d, cap layer of dirt covering coals left by second fire.

PART IV.

LITHICS STUDIES

NUMBER 5.

A STUDY OF THE EFFICACY OF USE-WEAR ANALYSIS AS A DESCRIPTIVE DEVICE FOR USE WITH THE H. S. TRUMAN RESERVOIR ARCHEOLOGICAL PROJECT ARTIFACT COLLECTIONS

by

Pamela J. Briney Bugbee

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INTRODUCTION

The following study is a test of the applicability of use-wear analysis as a tool in describing the Truman Reservoir Project lithic artifact collections. Use-wear analysis is believed to be capable of accurately reconstructing the way in which stone tools were used in processing certain classes of materials. If it can do so, use-wear analysis has the potential to provide a wealth of descriptive data in instances like the Truman Reservoir where lithic artifacts are virtually the only surviving evidence of human occupations.

The Place of Use-Wear in Descriptive Analyses

Use-wear analysis is only one of the techniques used by archeologists in reconstructing past societies and social units on the basis of their lithic technologies. The technique is not comprehensive enough to account for all aspects of a lithic artifact collection and, therefore, must be used in conjunction with other techniques.

Among the most often used descriptive techniques only use-wear analysis is specifically designed to isolate the use to which stone tools were put by their makers. This information is important in itself and because of confusion which may arise because of the use of certain morphological class names.

Some morphological classes in general use, such as axe, adze, hoe, and scraper imply function or behavior even

though the classes were developed on the basis of the physical similarities among the class members rather than on the basis of functional evidence (Dunnell 1978: 195; Schiffer 1979: 19; Hayden and Kamminga 1979: 3). This is critical because the available evidence indicates that there is no definite, consistent relationship between a tool's form and its function (Ahler 1971; Sonnenfeld 1958; Hammatt 1970; Walker 1978).

Use-wear analysis was developed, in part, to counteract this implication. The technique seeks to generate functional conclusions based on empirical evidence. Use-wear analysis rests on three basic assumptions. The first is that use of a stone tool produces patterns of macroscopic and microscopic damage which are relatively permanent indications of human use of the tool for a task. 'he second is that, through proper techniques, these patterns of use-related damage can be isolated from other forms of non-use-related damage. The third is that individual patterns of wear are a unique reflection of the way in which a tool was used to work a particular material or class of materials. The existing literature indicates that in certain instances these assumptions have been experimentally proven to be accurate. However, at their current stage of development, the diagnostic traits of use presented in the literature can not be applied directly to the analysis of lithic artifact collections.

The State of the Art

The literature is contradictory and presents more questions than answers regarding the meaning of damage traces found on archeological tools. Only a small portion of the available literature deals directly with the generation of unique patterns of use-wear damage which are believed to be diagnostic of certain tool-material contact situations. These diagnostic traits are the result of experimental programs which have been conducted in virtual isolation from each other.

Each of these experiments differs in orientation, methodology, and technique. These differences and the fact that each experimental program deals primarily with a single type of use-wear damage yield non-comparable results.

The literature contains no synthesis of these diverse forms. The various researchers do not fully endorse each other's work. Synthesis is necessary because no one type of use-wear patterning is sufficient in itself to analyse and describe an archeological collection. Each general type of use-wear evidence forms at different rates and under different circumstances. Accordingly, only one form may be present on any one tool and that evidence might be excluded

if the analysis was based on a single form of use-wear evidence.

Although each reported experimental program sought to perform a broad number of activities on an equally broad range of materials, they have not included the same range of tool-material contact situations suggested by the Truman collections. This leaves a void in which some tool-use situations are without diagnostic use-wear traits.

The reported experimental programs are also limited by the fact that the available diagnostic use-wear patterns were defined using only unmodified or minimally unifacially retouched blades and flakes.

The formation of damage patterns on stone tools is subject to a variety of variables, only some of which are the result of task behavior with finished tools. Each form of use-wear damage for which diagnostic traits have been isolated is sensitive to different variables, both utilization and non-utilization. Currently available experiments control only for those variables assumed to be relevant to that particular form of wear. For example, micropolishes are assumed to be sensitive only to the material being worked and the length of time used. Accordingly, only these variables are controlled despite the fact that other variables, such as manufacturing and post-deposition weathering, are capable of producing polishes.

The formation processes of the various forms of use-wear damage are only beginning to be understood. The literature in this area suggests that there are other critical variables such as the raw material utilized, trampling, and naturally produced patterns of damage to stone tools that may distort use-wear traces. This suggestion has not been extensively explored experimentally.

Further comprehensive experimentation is indispensable in evaluating use-wear analysis as a research tool and in applying the technique to archeological collections. In each instance, it must be demonstrated that tools like (both in form and in raw material type) those in the archeological collections to be analysed exhibit the same use-wear traits reported in the literature when used in similar ways on similar materials (Odell 1980: 119). This can never be assumed to be the case.

The need for further experimentation is also derived from other sources. First, all researchers agree that further experimentation is needed to verify and elaborate the existing knowledge. Second, the researchers agree that a use-wear investigator's ability to analyze archeological wear patterns is a direct result of that investigator's

experimental experience and knowledge of wear patterns formed on tools of known use. Third, the accuracy of an investigator's analysis of use-wear patterns on archeological specimens can only be ascertained through a "blind" test such as the one proposed for this study. Fourth, no test has been made of an investigator's accuracy in utilizing all forms of use-wear patterning. The two "blind" tests reported in the literature (Newcomber and Keeley 1979, the same as Keeley and Newcomber 1977; Odell 1980) deal with discrete kinds of use-wear patterning.

In light of the preceding factors, the following study is an evaluation and test of the utility of use-wear analysis as a research strategy for describing the Truman lithic artifact collections. Such a study is justified because the potential of use-wear analysis for generating descriptive data unavailable due to the lack of preservation of perishable materials such as vegetable fibers, hide, food stuffs, and bone, and because this technique is still in the developing stages and is not, in its present form, directly applicable to the Truman collections.

The study begins with a review and critique of the whole of the existing literature in the field. This will include a discussion of the various diagnostic use-wear traits available from the literature including the formation processes which have a bearing on their recognition, the variables accounted for by and the limitations on each class of use-wear indicators as recognized by their principle investigators, and other limitations suggested by other researchers.

The discrete diagnostic traits from the literature are synthesized to generate a model for research with replicated tools like those in the Truman collections. The model is limited by the definitions of diagnostic traits currently available. Therefore, only some of the experimental tools and tool-material contact situations can be expected to fit within the parameters of the model.

The model will be tested and expanded through a two part program of replicative experiments. The first portion of the experimental program is the development of a reference collection for use as verification and amplification of the literature, and as a guide for analysing archeological examples of the Truman Reservoir lithic artifact collections if the technique proves to be applicable. The second portion of the program is a "blind" experiment in which tools used without the knowledge of this investigator serve as a test of the investigator's accuracy in identifying the use-wear traces found on these examples.

Types of Lithic Use-Wear Experiments

As use-wear studies have developed, many experimental or quasi-experimental strategies have been utilized. They can be grouped roughly into four types. The first type could be called comprehensive experiments (Semenov 1964; Tringham et al. 1974; Keeley 1977; Keeley and Newcomber 1977; Newcomber and Keeley 1979; Odell 1980). Experimenters employing this strategy perform a wide range of experiments using a wide variety of operations on an equally wide variety of materials. In each experiment, however, a single tool is used for a single closely defined action on a single material. This is done to produce use-wear diagnostic of a particular action on a particular material. This aggregate is used to determine the use-wear patterns which are unique to particular actions, a particular material, or a particular action on a particular material. This strategy usually generates definitions of specific diagnostic features that are believed to be applicable, with some variations, to disparate archeological collections.

The second kind of experiment includes those which test a single morphologically defined tool class to determine whether or not the functions traditionally assumed for the tools being tested were those for which they were used (Nero 1957; Sonnenfeld 1962; Ahler 1971; Hester, Gilbow and Albee 1973). These experiments differ widely in their degree of complexity. Some, like that by Hester, Gilbow and Albee (1973), interpret archeological specimens, in this instance Clear Fork gouges, a bifacial tool form made from a different raw material, exhibit the same patterns in the hypothesized tool-material contact situation. Others, like that conducted by Ahler (1971), use replicated examples of a particular morphological class both for the traditionally accepted function and for other potential functions. Then, a research tool like factor analysis is used to differentiate archeological specimens into functional classes on the basis of the totality of wear found on the various replicated examples. These experiments are designed to generate functional classes within a single morphological class. The functional classes thus derived are applicable only to the morphological class studied. These experiments do not seek to demonstrate and do not demonstrate that the factors defining the functional classes are unique to an activity performed on a particular material regardless of tool morphology.

The third group is comprised of experiments designed to replicate an aboriginal activity set, such as butchering, using an appropriate lithic or other tool kit (Hammatt 1970; Sheets 1973; Walker 1978; Frison 1979). The primary purpose of these experiments is to reproduce a process. They are task oriented, not single-use oriented. A single tool is

generally used for a variety of actions (cutting, sawing, prying, etc.) and comes into contact with a number of materials during the same task. Although use-wear is generally noted, it plays a minor role in these experiments. Such experiments tend not to generate statements regarding unique, diagnostic wear patterns. They do, however, provide virtually all of the information in the literature regarding wear on bifacial and other extensively retouched tool forms and on multi-purpose tools.

The fourth group is only quasi-experimental. It includes studies of ethnographically known tools whose working context is well documented (Hayden 1979). It also includes ethnographic reports of direct observations of living societies utilizing stone tool technologies (Miller 1979).

Hayden's (1979b) work with Eskimo skin scrapers isolated several features that are important in defining use-wear patterns. One is a fracture type generally classed as "shatter fracturing" (Hayden 1979b: 210) with shallow diffuse linear features converging to wear the center of the edge which may be distinctive of skin scraping (Hayden 1979b: 213).

Ethnologies such as Miller's (1979) study of the Xeta Indians of Brazil can establish actual manufacturing strategies, preferred tool forms, and methods of tool manipulation which can yield more valid controls in replicative experimentation.

Both types of studies can act to confirm experimentally determined diagnostic features, to place such features in question, or to identify possible diagnostic features for future experimentation. They do not in themselves establish unique patterns of use-wear for application without further testing.

Of the above four types of experiments, only the comprehensive experiments (the first group) will be discussed in detail in the remainder of this paper. This is because they are the only ones which purport to yield individual diagnostic traits which are designed, theoretically, to predict the action performed with any tool, regardless of form, on any material. In order to have predictive value, a particular wear pattern must be shown not only to occur during use in a particular manner on a particular material, but also to be a unique result of that use (Sonnenfeld 1962: 60).

THE COMPREHENSIVE EXPERIMENTS

There are two main branches of comprehensive use-wear analyses which apply directly to the identification and interpretation of use-wear traces. The two are not wholly

separable; they differ primarily in the types of wear interpreted. While both have microscopic and macroscopic components, one tends more to observations with the unaided eye or low powers of magnification and the other tends toward microscopic observations at relatively high powers of magnification.

Macro-wear Analysis

The first type of use-wear analysis is generally referred to as macro-wear analysis. As its name implies, it deals with utilization damage observable with the unaided eye or at low powers of magnification. Its principle investigators are Tringham et al. (1974) and Odell (1975, 1980).

The analytical unit of observation in macro-wear analysis is edge damage, usually in the form of flaking or spontaneous retouch resulting from contact between the tool and the material worked during use (Keeley and Newcomber 1977: 35-36; Tringham 1974: 177).

This spontaneous retouch, as well as intentional retouch, occur according to the laws of brittle fracture (Cotterell and Kamminga 1979; Lawn and Marshall 1979; Tsirk 1979). Attributes of the worked item which act to resist external modification combine with applied force from the tool to form an internal force, "x," on the tool edge. Flaking occurs when the critical threshold between "x" and the internal tensile stress within the tool edge is exceeded (Ackerly 1978: 480). In this sense the portion of the edge in contact with the material being worked is equivalent to the striking platform of a core and, as in core technology, flakes are removed from the surface opposite that where the force is applied (Tringham et al. 1974: 186-187; Tsirk 1979: 83).

Tringham et al. (1974) consider utilization flaking as potentially the most useful criterion for identifying use-wear, considering its sensitivity to variation in the action performed and the material worked with the tool. Recent work with fracture mechanics in relation to lithic technology tends to support Tringham et al.'s view regarding action and material (Cotterell and Kamminga 1979: 103; Lawrence 1979: 115; Tsirk 1979: 86).

The potential of the macro-wear technique lies in its ability to reconstruct the way the tool was manipulated and the relative hardness of the material worked. The results of the experiments showed that the mode of action, e.g., cutting, scraping, boring, was indicated by the distribution of the utilization scarring and that the relative hardness of the material worked was indicated by the character of

the scars, e.g., their size, shape and sharpness of margin (Tringham et al. 1974: 188).

Odell's work, published in April 1980, is an extension of Tringham et al. and offers general support to the conclusions reviewed above.

Micro-wear Analysis

The second major branch of use-wear analysis is generally referred to as micro-wear analysis. Its basic units of observarion are striations and "polishes" (Keeley 1977: 108; Keeley and Newcomber 1977: 35-36; Semenov 1964). Both units are relatively permanent alterations of the microstructure of a tool's surface resulting from its use. Both are microscopic forms rarely visible in the absence of high powers of magnification.

The generative factors and distinctive characteristics of these forms are currently the subject of debate and restudy. As originally defined by Semenov (1964: 4), striations are minute lines, scratches, or grooves showing the direction of movements of the tool and its position on the object being worked. Kamminga (1979: 148) identifies two kinds of striations or linear configurations resulting from work. The first type is a sleek. Sleeks have regular margins and are unique in that they form by the plastic deformation of hydrolized silica at the surface of the tools used to work plant materials. The second type is a furrow. It has irregular margins which appear torn, broken, or shattered as a product of micro-fracturing. They may be continuous or discontinuous. Other current research indicates that some striations seemingly associated with skin working are shallow linear depressions (Hayden 1979a: 192-193) and that striations on rough surfaces appear as a series of dotted lines (Del Bene 1979: 173).

Striations are formed by the introduction of abrasive particles between the tool surface and the material being worked (Semenov 1964: 15). These abrasive particles may be either foreign matter such as dust or sand adhering to the worked material or fragments or flakes which detach from the contact surfaces of the tool and lodge in or on the worked surfaces (Kamminga 1979: 151-152; Semenov 1964: 15).

Semenov (1964: 5, 16-21) contends that the distribution and orientation of the striations or the "geometry of traces" express the kinematics of the human and in utilizing a tool in a particular fashion and that as such striations reflect unique and identifiable ways of manipulating a tool in performing a task.

Polishes are microscopic alterations of tool surfaces believed to be distinctive in gross terms depending upon

the material being worked (Semenov 1964: 23; Keeley 1977: 111; Keeley and Newcomber 1977: 37). Experiments by Keeley (1977) and Keeley and Newcomber (1977) resulted in precise definitions of the character of individual polishes. Identifiable polishes include only generic substances such as wood, bone, antler, and meat. They are not specific enough to differentiate species within these generic classes (Keeley 1977: 111-116; Keeley and Newcomber 1977: 37). Polishes can also identify the position of the human hand while manipulating an unhafted tool (Semenov 1964: 3). Micropolishes have the advantage in use-wear studies of responding only to the material worked and the amount of duration of use (Semenov 1964: 83; Keeley and Newcomber 1977: 35, 36, 39).

Lack of Synthesis

Although some of the investigators do use some microwear traits in primarily macroscopic identification (Odell 1980: 113-115) or use some macroscopic traits in primarily microscopic identifications (Keeley and Newcomber 1977: 45-59), there has been no systematic attempt to apply the methods and techniques of both micro-wear and macro-wear in a single experimental program. This lack is derived from the reservations which the adherents of one particular technique have regarding the utility of the other technique.

Tringham et al. (1974) consider the use of striations as the main criterion in use-wear analysis to be highly impractical in the examination of large archeological assemblages (Tringham et al. 1974: 175). They object to the microwear technique because striation formation is slow and unstable and because of the high magnifications and prior processing necessary to see them (Tringham et al 1974: 175). Polishes are not discussed by Tringham et al. because they were not formally defined until 1977 (Keeley 1977; Keeley and Newcomber 1977). Odell (1980: 88-89) reiterates these objections and adds to them the substantial expense and time required for the microwear technique, as well as Keeley's own admissions regarding the uncertainties of polish identification and the fact that Keeley's results have not been shown to be applicable to other raw materials.

Keeley and Newcomber have reservations regarding the diagnostic value of macrowear traits. They note that other agencies such as soil movement, human activities of manufacture, transport and disposal can create damage patterns like macroscopic use-wear and like intentional retouch (Keeley 1974: 327; Keeley and Newcomber 1977: 35-36). They also cite the difficulties in distinguishing use-wear damage from similar damage occurring from intentional retouch (Keeley and Newcomber 1977: 35, 55).

All of these objections are discussed in more detail in the following sections.

Comparability of the Comprehensive Experiments

None of the currently available comprehensive experiments are strictly comparable in terms of orientation, kinds of wear studies, range of actions and materials, variables controlled, and techniques of observation. Therefore, their net effect is a broadening of the base knowledge rather than a cumulative increase in knowledge.

DIFFERENCES IN ORIENTATION

None of these experiments are strictly comparable in terms of orientation. Semenov's orientation i, a generalizing one. His experiments seek to establish the function of a tool by testing hypothesized functions generated by the totality of the wear found on an archeological example (Semenov 1964; Levitt 1979: 28). If, after use for the hypothesized function, an experimental tool shows the same kinds and distributions of wear as the archeological example, the hypothesized function is accepted. While this orientation is not designed to generate unique diagnostic traits, some of Semenov's results are presented in a way that suggests that they can be utilized as diagnostic traits (Semenov 1964: 16-21; Keeley 1974: 328).

Tringham et al.'s, Odell's, Keeley's and Newcomber's orientations are particularizing ones. Their experiments seek to isolate individual patterns of use-wear which will define a particular tool to material contact situation regardless of the form of the tool. Their results are not sufficient to establish tool function (Tringham et al. 1974; Odell 1980; Keeley 1977; Keeley and Newcomber 1977).

KINDS OF WEAR STUDIED

Each of the four experimental programs deals primarily with a single kind of diagnostic use-wear damage. Each type is limited in the amount and kind of information it can provide. Striations, the type used by Semenov (1964), reveals the position of the tool in relation to the material being worked. Macrowear, the type studied by Tringham et al. (1974) and Odell (1980) is sensitive to the stroke, e. g., cutting or sawing, and the relative hardness of the material being worked. Micro-polishes, the use-wear type studied by Keeley (1977) and Keeley and Newcomber (1977) is sensitive basically to the material being worked, e.g., wood, bone, hide, although the distribution of wear can provide some indication of the amount of penetration into the material worked.

RANGE OF ACTIONS AND MATERIALS TESTED

Although these definitional experiments seek to be as comprehensive as possible, they have not dealt with all pertinent tool-to-material contact situations. The scope is implicitly restricted to those situations expected for hunting and gathering societies, e.g., meat and plant processing and manufacturing bone, antler and wood implements. Digging functions are not included because of their associations with horticultural societies. This precludes the possibility of identifying soil related wear on stone implements potentially used like digging sticks in gather operations. Additionally, not all expected actions and materials pertinent to hunting and gathering societies are tested in each instance.

Tringham et al.'s macrowear experiments involved 79 tools tested over a four-year period. Individual tools in this group were used for the actions of cutting, sawing, whittling, graving, scraping, shaving, and boring. A variety of materials including antler, bone, hard and soft wood, meat, fresh and tanned hide, and dried grass were processed using those modes of action (Tringham et al. 1974: 176). Lacking in these experiments were tools used for multiple activities, for chopping or other percussive actions and tools used to process fresh plant materials or to dig or hoe.

Odell's experiments generally follow the same lines as Tringham et al.'s with the addition of chopping, grinding, pounding, and digging modes of action and soil and fresh plant materials (Odell 1980: 110-112). This report was not, however, available until after the experiments described in this paper were designed and conducted. Therefore, his experimental results will be used only for purposes of comparison in discussing the results of this experimenter's investigations.

As noted in the section regarding the orientation of the comprehensive experiments, Semenov's work (1964) differs widely from the other programs yielding diagnostic traits. His reports available in English provide incomplete information regarding the actions and materials on which his results are based.

The micro-wear experiments conducted by Keeley (1977) are similarly incomplete, Keeley (1977: 111) states that he conducted a series of nearly 200 tests on a variety of materials. He does not, however, provide any additional details regarding those tests. The reports of Keeley and Newcomber's blind test (Keeley and Newcomber 1977: 45-59; Newcomber and Keeley 1979: 203) record whittling, chopping, sawing, cutting, scraping, and boring actions variously on wood, meat, fresh

hide, bracken, and bone with a total of 16 tools. In this case, the actions were not defined, and it is possible that cutting here could be the same as Tringham et al.'s sawing motion. Again dirt and digging activities were not included in the experiments. Also, multi-material contacts such as those found in dismembering a carcass are not included.

In all instances, so far as data are available, the same actions were not always performed on the same materials. This is due primarily to differences in the focus of the experiments.

VARIABLES CONTROLLED

Different variables are controlled in each instance. This is done because each type of wear is subject to different variables and only those believed to be pertinent to the use-wear being studied are controlled.

The macro-wear forms studied by Tringham et al. and Odell control the mode of action and the relative hardness of the material being worked (Tringham et al. 1974: 178, 181-184; Odell 1980: 98-102). These variables are controlled by closely defining the action or the way in which the tool was moved during use and by developing a scale of relative hardness based on the amount of resistance offered by a particular material being processed. Tools are generally used for only one action on a single material; multi-action and/or material tools are rare.

The striation studies by Semenov are believed to indicate the position of the tool in relation to the material being worked (Semenov 1964: 16-21). Unfortunately Semenov's translated works do not include a detailed account of his experimental controls (Keeley 1977; Semenov 1964). Keeley, in his work with striations, notes that striations on both experimental and archeological tools do not fit Semenov's definitions (Keeley and Newcomber 1977: 37); however, he gives no information regarding his controls, if any, for this variation. He does not closely define the manner in which his tools were moved.

The micro-polishes are believed to be sensitive only to the material being worked and the duration of use (Keeley 1977: 112; Keeley and Newcomber 1977: 39); therefore, only these variables receive detailed attention.

In each instance, experimental controls for similar but non-use related damage forms are rare or absent. These will be discussed in the following sections.

TECHNIQUES UTILIZED

Macro-wear studies are normally conducted according to what Odell (1980) terms the low-power approach. This approach uses levels of magnification between 10X and 60X with most identifications being made at 20X - 40X (Tringham et al. 1974: 185; Odell 1980: 90). These levels contrast sharply with those employed in micro-wear studies. In these, magnifications of between 100X and 400X are used with identifications of polishes being made at 200X - 300X (Keeley 1977: 110-112; Keeley and Newcomber 1977: 36-37; Newcomber and Keeley 1979: 199).

These differences in technique restrict macro-wear investigators' chances of isolating, let alone identifying, polishes (Keeley 1974: 324). Polishes become visible at 100X and identifiable at 200X (Keeley and Newcomber 1977: 36). At lower magnifications only well developed phytolith polish can be observed (Odell 1980: 114).

The Limitations of Use-Wear Analysis

While the comprehensive investigators have been conscientious in their attempts to develop diagnostic use-wear indicators, their results are limited by factors both within and beyond their control. These include the identity of use-wear forms, the ability of use-wear analysis to isolate function and the effects of tool form and raw material types on the currently available definitions of diagnostic traits.

Use-wear analysis is also limited by problems in distinguishing use-wear features from other intentional and incidental damage forms. This is a complex problem which will be dealt with in its own section.

THE IDENTITY OF USE-WEAR FEATURES

There is general agreement among researchers that use-wear traces do exist and that they can, theoretically, provide concrete information regarding the tasks performed with particular tools. However, there is general disagreement regarding the nature of the use-wear indicators and their utility in describing lithic artifact collections.

As noted in the section regarding kinds of comprehensive experiments, macrowear damage forms according to the laws of brittle fracture. However, at this time the laws of brittle fracture cannot be used to predict the scars resulting from particular contact situations (Hayden 1979a: 138 comments by Falkner; 298, comments by Cotterell). These laws were developed through the industrial testing of sheets of airline and windshield glass (Lawn and Marshall 1979: 63)

and are not capable of fully explaining fracture patterns resulting on the uneven surface of a stone tool's edge.

Additionally, the mechanical forces which yield use-wear scarring can also be produced by human non-use related manipulation and by natural forces. Therefore, the existence of a scarring pattern on a tool edge does not automatically indicate task related behavior. The problem of differentiating use-related scarring from all other forms will be discussed in more detail in a following section.

Micro-polishes are the subject of much greater debate regarding the mechanisms of their formation, whether or not they are in fact polishes, and their diagnostic value.

Kamminga (1979: 144-151, 154) considers phytolith polish, or plant polish in Keeley's terminology, to be the only true polish found on stone tools. While this polish was once believed to be an additive process (Witthoft 1967), Kamminga believes that the phytolith polishing mechanism is the same as that operating in optical glass polishing (Kamminga 1979: 151). He sees the polish as a chemical bonding resulting from the chemical interaction between the opaline silica in plants, water in the plants and the tool's surface (Kamminga 1979: 149, 151, 154). He further believes that all other forms called "polish" are actually products of abrasive smoothing resulting from mechanical rather than chemical agencies and should not be referred to by that term (Kamminga 1979: 151-154). There is some agreement with this position among other researchers (Del Bene 1979: 171).

The diagnostic value of polishes is also being questioned. All researchers surveyed for this paper agree that phytolith or plant polish is unique and recognizable. Kamminga (1979: 151) contends, however, that abrasive smoothing or mechanical polish is not indicative of individual worked materials. Although Keeley and Newcomber disagree, other researchers have been unable to replicate their results (Keeley 1974: 324,325; Hayden 1979a: 286 comments by Kamminga). Although these failures seem to be attributable to technique (Keeley 1974; Hayden 1979a: 193 comments by Keeley), it does have important implications regarding the utility of polish as a use-wear attribute.

ABILITY OF USE-WEAR ANALYSIS TO ISOLATE TOOL FUNCTIONS

While all of the comprehensive experimenters view their efforts in terms of isolating the function of lithic artifacts (Semenov 1964; Tringham et al. 1974: 171; Keeley 1975: 323; Keeley 1977: 108; Keeley and Newcomber 1977: 29; Odell 1980: 88), their results suggest that use-wear analysis alone is incapable of doing so.

At its present stage of development use-wear analysis is capable of identifying the area of the tool utilized, the direction of its movement and the gross identity of the contact material; but it is incapable of specifying the precise function of the tool (Tringham et al. 1974: 195; Hayden 1979a: 284 comments by Lawrence, 285 comments by Keeley). It does, however, identify a particular tool and material contact situation.

The addition of information regarding the archeological and ethnohistorical context of the artifacts studied to the equation generated by the results of the use-wear analysis of the same tools can potentially yield answers regarding tool function.

Failure to include such data can result in major misinterpretations such as Keeley's diagnosis of a Beaker dagger as a hide processing tool on the basis of its use-wear traces before he discovered from the literature that these forms had leather sheaths (Hayden 1979a: 284-285 comments by Keeley). In that instance, the traces identified the activity of sheathing the dagger but not its function as a weapon.

THE EFFECT OF EXPERIMENTAL TOOL FORMS ON THE UTILITY OF REPORTED DIAGNOSTIC USE-WEAR TRAITS

The scope of the comprehensive experiments is also restricted by the fact that only unmodified or minimally unifacially retouched blades and flakes or ground stone tools were used in the majority of the experiments. This strategy has been employed in order to minimize the development of complex and confusing traces (Tringham et al. 1974: 175, 179, 181) and to prevent clues to use derived from the tool form in test for accuracy of identification (Keeley and Newcomber 1977: 29, 34; Newcomber and Keeley 1979: 195). This procedure was followed despite the investigator's knowledge that intentional retouch can profoundly affect the character of use-wear traces (Semenov 1964: 4; Tringham et al. 1974: 175; Keeley 1977: 110; Keeley and Newcomber 1977: 35, 55).

While this strategy is justified for the reasons given, the absence of experimentation with bifacially or other extensively retouched forms has left a void in the literature regarding diagnostic use-wear traits for retouched tool forms.

There are indications in the literature that the void may have major repercussions in situations, like that found in the Truman lithic collections, where the majority of tool forms isolated by other techniques is primarily bifacial and extensively retouched. Hayden's (1979b) studies of bifacial Eskimo skin scrapers indicate that fracture types defined by the literature are subject to a great deal of background

"noise" (Hayden 1979b: 217) such as zones of "shatter fracturing" (Hayden 1979b: 20, 24) which make it questionable whether or not the existing fracture patterning is meaningful (Hayden 1979b: 17). Controlled comprehensive experiments by Odell confirm that currently available diagnostic macro-wear traits are insufficient to analyze and identify the complex scarring patterns observed on bifacially retouched tools (Odell 1980: 109, 115).

This problem is not confined to macroscopic wear. Semenov and other researchers have confined their experiments primarily to flakes, blades or ground stone tools because of the difficulties in identifying and replicating patterns of striations and polishes on chipped stone tools (Semenov 1964: 15; Levitt 1979: 29). Studies by Del Bene indicate that striations like those defined by Semenov (1964) tend to form and to be preserved only on relatively smooth surfaces. On retouched areas they appear as discontinuous chips and holes which are difficult to isolate and identify (Del Bene 1979: 172, 173).

RAW MATERIAL

Currently available definitions of use-wear traces are also limited because they are drawn from experiments utilizing European chalk flint (Tringham et al. 1974; Keeley and Newcomber 1977; Newcomber and Keeley 1979; Semenov 1964). Flint differs substantially in terms of hardness and grain size from lithic materials utilized aboriginally in North America and can be expected to show significant differences in fracturing patterns.

Semenov's approximately 40 years of work in use-wear analysis have indicated that "different stone types vary in their intensity of wear and the degree and character of deformation which they exhibit post utilization" (Semenov 1964: 17). Despite this knowledge, there has been relatively little study of the relationship of use-fracturing and raw material variation (Greiser and Sheets 1979: 289). Differential fracturing of various lithic materials would be expected given the facts that local inhomogeneties cause fractures to deviate from the ideal path (Cotterell and Kamminga 1979: 99) and that an isotropic solid, including coarse grained materials, follow a tendency toward preferred cleavage around grains (Lawn and Marshall 1979: 66). Experiments by Greiser and Sheets (1979) confirm this expectation through experimental wood sawing with lithic tools ranging from obsidian to quartzite with all variables but raw material held constant.

This restriction of raw material type has important implications. Keeley notes that difficulties experienced by other researchers in identifying discrete mechanical

polishes may be due to the quality of the raw materials being studied (Hayden 1979a: 193 comments by Keeley). Additionally, Odell's results indicate that discrete modes of action such as cutting and sawing cannot be differentiated for tools made of basalt (Odell 1980: 98, 109). Semenov's research indicates that the clarity and intelligibility of striations depend in part on the raw material with flint providing the best surface and chert yielding poorer results which vary according to the grain size (Semenov 1964: 15).

Distinguishing Use-Wear From Non-Use Related Damage

The ideal system of experimentation, identification of use-wear and its application to archeological collections is deceptively simple (Schiffer 1979: 17). A host of variables, both pre-deposition and post-deposition, can affect the character of the use-wear traces produced and preserved or produce, by natural agencies, traces which may be mistaken for traces of human utilization. Only some of these have been subject to any experimental controls.

RETOUCH VS. USE-WEAR SCARS

The problem of distinguishing retouch scarring from use-wear scarring is not settled. Tringham et al. (1974: 181) contend that retouch scarring as opposed to utilization damage produces much larger scars which encroach further over the surface of the tool, have sharper edges, and are more regular in shape, size and distribution. This contention has not been confirmed by Keeley's experimental work (Keeley and Newcomber 1977: 35). His results indicate that it is impossible to distinguish the smaller components of retouch and subsequent use-wear damage (Keeley and Newcomber 1977: 35).

Additionally, studies by Knudson (1979) and Flenniken (Hayden 1979a: 370 comments by Schiffer) indicate that incidental damage can yield scars synonomous not only with use-wear but also with intentional retouch.

MANUFACTURING VS. USE-WEAR DAMAGE

The manufacturing process itself is capable of producing both macroscopic and microscopic damage forms like those resulting from tool use (Semenov 1964: 13, 49, 50; Sheets 1973; Keeley 1974: 327). Manufacturing damage due to platform preparation and the action of hammerstones is relatively easy to distinguish from use-wear by its distribution in flake/blade technology (Semenov 1964: 13, 49, 50; Keeley 1974: 327) and on retouched but unutilized edges (Sheets 1973: 217-218). However, the literature contains no guidance for distinguishing manufacturing and use-related damage on retouched and subsequently utilized edges.

INCIDENTAL DAMAGE FROM HUMAN NON-USE ACTIVITY VS. USE-WEAR DAMAGE

At present there are few experimental controls for distinguishing use-wear damage from damage caused by other human manipulations of finished tools.

Tringham et al. (1974: 192) have shown that human trampling of tools tends to produce random distributions of elongated scars around the perimeter of a tool on the face opposite the trampling pressure; these scars are not standardized by either size or shape. Tringham et al. contend that this pattern is easily distinguished from use-related scarring patterns. These tend to be localized and to be made up of scars having the same general orientation, size and shape (Tringham et al. 1974: 191-192).

Other experiments (Hayden 1979a: 370 comments by Schiffer) and studies (Knudson 1979) have shown known trampling damage which was patterned enough to be mistaken not only enough to be mistaken not only for utilization damage but also for intentional retouch.

Although modern trampling damage and other forms of incidental damage resulting from excavation, bagging, transportation and subsequent handling of the artifacts can be distinguished from pre-existing damage by their fresh fracture surfaces (Tringham et al. 1974: 191-192), there is no known method for distinguishing aboriginal incidental damage from use-wear evidence (Hayden 1979a: 371-372 comments by Hayden).

DAMAGE FROM NATURAL CAUSES VS. USE-WEAR DAMAGE

Both before and after deposition, a number of natural processes act on lithic artifacts. Some of these are capable of producing damage synonomous to use-wear traces. These forces have received negligible attention in the literature.

Tringham et al.'s experiments with water-rolled flakes indicate that these tools developed a random distribution of scars around the entire perimeter of both faces with no standardization of scar size, shape, or orientation (Tringham et al. 1974: 191). Retouched tools were not tested, and no polish results were reported. Polish can be expected on water-rolled artifacts in light of the high polish development normally found on river cobbles.

At present there has been no reported work designed to control for natural polish formation. This is critical because while polishes are less sensitive to damage than macrofracturing, they are not impervious to alteration. Polishes

may be formed by agencies other than materials worked (Semenov 1964: 11-16; Kamminga 1979: 144; Del Bene 1979: 170). These natural polishes include patination, water action, "desert varnish," wind abrasion, carbonate deposition, chemical action, and thermal alteration. Although the literature recognizes these polishing agents, it includes no study of their characteristics vis a vis those derived from contact with worked materials.

Even after deposition, lithic artifacts are not protected from incidental damage which can affect the results of any use-wear analysis. Another natural phennomenon, pedoturbation, acts to sort and move buried archeological specimens (Wood and Johnson 1978). Of particular interest are cryoturbation (disturbance by freeze-thaw action; Wood and Johnson 1978: 333-346) and agrilituirbation (disturbance by expanding and contracting clays; Wood and Johnson 1978: 352-358). Although their mechanisms are different, both forms operate through alternate compression and decompression which act to move buried materials varying in size from sand grains to boulders both vertically and horizontally through the soil matrix. This situation includes both the abrasive materials and the loading conditions active in the formation of use-wear traces. It is conceivable, although not documented, that some observed damage on artifacts is the result of pedoturbation rather than utilization. For this reason it is important to know the depositional context and probable depositional history of lithic materials undergoing use-wear analysis (Sheets 1973: 215).

While controls for the effects of these natural damage producing agents are badly needed, there is some justification for the current lack of experimentation in the area. Forces like pedoturbation act slowly and their effects are the product of years. Even the most minimal replication experiments would require at least two years; a period which usually is unavailable, as in this study.

Confidence Levels For Use-Wear Analysis

Despite the problems and flaws in use-wear analysis, there is encouraging evidence that use-wear analysis is capable of a relatively high degree of accuracy in identifying tool material contact situations. This evidence is the result of two "blind tests," one dealing with micro-wear indicators (Keeley and Newcomber 1977; Newcomber and Keeley 1979) and one dealing with macro-wear indicators (Odell 1980).

BLIND TESTS - MICRO-WEAR

Newcomber (independently of Keeley) prepared and utilized an experimental set of 16 tools made from European chalk flint (Newcomber and Keeley 1979: 195-198). The tools

were used for a variety of actions on a variety of substances. Notes were taken during utilization, and drawings were made of the tools. All of the tools were unmodified flakes or simple unifacially retouched tools. Upon completion of the experiments, the cleaned tools were sent to Keeley for his evaluation. Using established methods of micro-wear investigation, Keeley examined the specimens, made his conclusions and compared them to the notes taken by Newcomber (Newcomber and Keeley 1979: 198-202).

Keeley's accuracy in identification was scored for three different criteria: area of the tool used; reconstruction of the tool movement; and identification of the material worked (Newcomber and Keeley 1979: 202-204). Keeley identified correctly 14 of 16 areas utilized or 88%, 12 of 16 tool movements or 75%, and 10 of 16 materials or 63%. His overall percentage correct of the available 48 possible identifications was 75%.

Some of the errors are attributable to human fallibility; others are attributable to limitations in the method. Failure to identify the area utilized and subsequent categories for the tool used to scrape fat from hide stems from the failure of fat to leave recoverable wear traces (Newcomber and Keeley 1979: 200). Errors in reconstructing movement are due to the distribution and the aspect of the polish and striations (Newcomber and Keeley 1979: 203-204). These distributions were not consistent with Keeley's prior experimental results for the same use and were the result of unexpected techniques of tool manipulation. Errors in the identification of materials worked stemmed from several sources (Newcomber and Keeley 1979: 204). One resulted from cutting meat on a wooden cutting board thus yielding confusing traces. Others were the result of greater than expected variability in bone polish and the fact that polishes formed on antler and on wood seasoned for 10 years are indistinguishable. A variable in all of the results was the degree of polish development. This correlates generally to the amount of time a tool was used and/or to the amount of friction produced during utilization.

BLIND TEST — MACRO-WEAR

Odell's blind test was patterned after Kelley's and Newcomber's test (Odell 1980: 90-91). The procedures for experimental design and tool and experimental security prior to identification were generally the same (Odell 1980: 91-96).

This experiment differs, however, in important respects from the micro-wear version. It was designed to test macroscopic use-wear damage under low power techniques and therefore does not replicate Keeley and Newcomber's findings (Odell 1980). The raw material utilized was fine grained

basalt (Odell 1980: 91). The tool kit was larger, 31 tools, and included 3 tools with bifacial edge retouch (Odell 1980: 19, 95). The experiments included additional modes of action and materials not tested by Keeley and Newcomber (Odell 1980: 95, 110-112). Examples of these are pounding and grinding actions, nuts, both shells and meat, and dirt.

Odell's results were scored for four different criteria: area of the tool used; activity; relative hardness of worked material; and exact worked material (Odell 1980: 112, 113). Odell correctly identified 24.5 of 31 areas utilized or 79%; 21.5 of 31 activities or 69.4%; 19 of 31 relative hardnesses of materials or 61.3%; and 12 of 31 exact materials worked or 38.7% (Odell 1980). While he did not present an overall rating of his accuracy on all possible identifications, it is easily calculated as 77 of 124 or 62.2%.

Some of Odell's errors in identification are quite instructive in terms of the variability and limits of use-wear analysis. First, the actual distribution of damage produced by an action such as sawing does not always match that defined for the action (Odell 1980: 109). Second, some actions, like graving and boring, can produce the same kind and distribution of use-wear damage and are, therefore, indistinguishable (Odell 1980: 112-113). Third, battering on the edges from intentional retouch obscures use-wear traits to the point that they are unidentifiable; this is true of both unifacial and bifacial retouch (Odell 1980: 109, 114). Fourth, it appears that error can be generated by the investigator's expectation regarding the activities performed. Odell misidentified the one digging implement in the test in part because it was unexpected and in spite of clear evidence on the tool precluding its hypothesized use (Odell 1980: 113). Fifth, some activities, such as nut crushing and grinding, leave no recognizable macroscopic traces even after long use (Odell 1980: 114). Sixth, unused tools can display kinds and configurations of macroscopic damage that fit easily within the definitions of use-wear damage (Odell 1980: 114).

CAUTIONARY NOTE

While the success rates for both blind experiments are relatively high, the expectations of accuracy that they generate must be viewed with caution. They are based on many years of experience in use-wear investigation by the principle investigators in the field and are a direct result of that depth of experience (Keeley and Newcomber 1977: 37; Odell 1980: 118). It is unlikely that less experienced investigators can expect the same level of results.

The blind tests also suffer from the limitations such as raw material and tool form described in the preceding sections. It has not been demonstrated that even the experts can achieve the same results given different raw materials and an increased number of extensively retouched tools.

THE MODEL

The following is a model of diagnostic use-wear traits synthesized from the reported comprehensive experiments by Semenov (1964), Tringham et al. (1974), Keeley (1977), and Keeley and Newcomber (1977). (Odell's [1980] results are not included in the model because they were not published until after the present experimental series had been conceived and was virtually completed.) They represent ideal or expected configurations of use-wear damage. They are used with the recognition that, because of differences in raw material and tool form, the Truman replicated examples can also be expected to vary from this norm.

Mode of Action

Table 1 represents the totality of diagnostic wear traces which are believed to be indicative of the mode of action or the way in which a tool was moved during use.

The actions listed are drawn primarily from Tringham et al. (1974: 188-189) and follow the precise definitions used there. Cutting is a one-way longitudinal movement either toward or away from the operator. Sawing is a two-way longitudinal movement both toward and away from the operator; sawing is not restricted to hard materials. For both cutting and sawing, both surfaces of the tool are in contact with the material being worked. Transverse cutting is a one-way movement either toward or away from the operator. In this instance, only one surface of the tool is in contact with and receiving pressure from the worked material. Transverse cutting includes activities such as scraping, shaving, and planing. Boring is the circular movement of a point or projection on a tool.

The actions called piercing, graving, and chopping are defined according to Semenov (1964: 18-21). Piercing is the penetration of a material with a point or projection by a continuous downward thrust. If a twisting action is also used, the activity is termed boring. Graving is the incising of a material in a one-way movement with a point or projection. Chopping is a percussive action in which both faces of the tool penetrate the material being worked.

TABLE 1

The Model — Modes of Action

Action	Macroscopic Scarring	Striations	Polishes
Cutting	Scarring uneven and distributed on alternating faces of the edge. Scars are of no particular shape or size. This formation is found along entire length of utilized area.	Striations are found on both faces along the edge. They may be parallel to the edge or may cross cut each other depending on the cutting plane.	Not applicable.
Sawing	Scarring is the same as for cutting except that there is a greater density of scars and they are distributed equally on both faces of the edge.	Striations are found on both faces parallel to the edge; they can be uniform on both faces.	Rough antler polish is associated with sawing.
Transverse Cutting	Scars occur only on surface opposite the one in direct contact with the material being worked. The scars are regular in size and shape.	Striations occur only on the face of the tool which is in contact with the material being worked. They run either perpendicularly to or diagonally from the edge depending on the direction of applied force.	Smooth antler polish is associated with transverse cutting.
Piercing	Piercing is not discussed.	Striations occur parallel to the axis of the tool.	Not applicable.
Boring	Scars occur on the sides of the point or projection, not on the tip of the tool. The distribution of the scars indicates either one-way or reverse action boring. Trapezoidal but not triangular scars are associated with this action.	Boring yields circular lines occurring at right angles to the tool. The degree to which these lines are parallel to each other depends on both the material and the method of boring. Bow drilling yields virtually parallel lines; hand drilling, either one-way or reverse action, yields less parallel lines. Piercing with a twist yields lines parallel to the axis which are cross cut at a 90° angle by circular lines.	Not applicable.
Graving	Graving is not discussed.	Striations occur on the side edges parallel to the cutting plane but generally at approximately right angles to the axis of the tool.	Not applicable.
Chopping	Chopping is not discussed.	Striations occur uniformly on both faces. They run diagonally on the blade of axes. They are parallel to the axis of the tool and are more prominent on one face of adzes. On hoes striations occur at an angle to the axis of the tool and tend to intersect each other. Striations are more prominent on one face for hoes.	Not applicable.

TABLE 2

The Model — Relative Hardness of Materials

Relative Hardness	Materials	Macroscopic Scarring	Polishes
Soft	Meat Fresh hide Dry or tanned hide Plants Fish	Soft materials yield scalar scars. These are generally small; slight nibbling in the upper range. Fish scaling offers more clearly defined scalar scars.	Meat: Relatively dull with a pronounced greasy luster. It shows little contrast with the rest of the unaltered surface. There is very slight surface smoothing; minute elevations and depressions are retained. Few striations form; they are generally a result of cutting joints and tendons. When formed, they are narrow and deep. Fresh hide: Greasy, slow forming polish similar to meat polish. The polish becomes more pronounced as the hide becomes drier. Polish is accompanied by severe edge attrition and diffuse linear features similar to but less distinct than striations. Dry or tanned hide: Dull polish with an intensely matte finish. This sometimes occurs with tiny "pot lid" type pits. Dry hide working also yields severe edge attrition and the linear features described for fresh hide. Plants: Polish has a very smooth highly reflective surface with a "fluid" appearance. Striations are generally filled in. Comet-shaped pits sometimes occur.
Medium	Hard and Soft wood	Wood working produces four scar shapes: scalar, snap, triangular, and trapezoidal. Trapezoidal scars occur only in wood working and generally only with a sawing motion. Hard wood may eventually yield small scale step scars. Scalar scars from wood working are smaller and shallower than those from bone. All of the scars associated with wood working have finely abraded or fuzzy margins.	Wood: Polish is consistent whether it is produced by hard or soft wood. The polish is very bright and has a smooth texture. In the early stages of use, polish forms as curved or domed areas. In the later stages of work, the domed areas link up to form an undulating surface. The crests and troughs of this surface run in the general direction of use. In the early stages of use, the character of the chert affects the formation of the polish.
Hard	Bone Antler	Hard materials produce step scars which gradually obliterate the original scalar scars. The rear margins of both scalar and step scars are clearly defined. The side margins of these scars are heavily abraded and crushed. After working hard materials, tool edges are irregular and have numerous projections. Working antler produces the greatest amount of edge destruction. Working bone produces mainly large scalar scars.	Bone: Polish is bright with a rough, pitted uneven texture. The polish is seldom as bright as wood polish. The polish is distinguishable due to the presence of numerous pits less than one micron in diameter. The polish forms more slowly than wood polish and is seldom extensively developed. Bone polish forms only on the elevations of the chert surface and does not spread or link. The polish is consistent for both cooked and fresh bone. Antler*: There are two distinct antler polishes. They differ according to the action or motion performed. Smooth antler polish is a result of scraping, planing, or graving. In its

TABLE 2: Continued

The Model — Relative Hardness of Materials

Relative Hardness	Materials	Macroscopic Scarring	Polishes
			early stages of development it is virtually indistinguishable from wood polish. When polish is well developed, the surface displays small diffuse pock marks, which resemble those in a melting snow bank. Rough antler polish results from sawing antler. The polish is similar to bone polish but lacks the distinctive micro-pitting or "pot lids" associated with bone polish. *The antler polishes described above were defined from working antler that had been soaked in water for two or three days. Keeley believes that fresh antler should produce similar results. Dry antler produces severe edge damage to the tool with little modification of the antler.

Worked Materials

Table 2 represents all of the diagnostic use-wear features believed to be indicative of the material being worked with stone tools. Because the micro-wear and macro-wear approaches differ in their ability to specify materials, Table 2 has two basic components. The relative hardness of the materials relates to the macroscopic damage forms. The classes are drawn from Tringham et al. (1974: 189-190) and are comprised of the materials listed in the materials column. The polishes are taken from Keeley (1977: 112-116) and Keeley and Newcomber (1977: 39, 42, 44).

Variation in Use-Wear Indicators

The ideal forms presented in Tables 1 and 2 must be used with caution. Although both macroscopic and microscopic use-wear indicators are believed to be unique and relatively unambiguous indicators of material and/or mode of action, there is some variance in their formation.

The greatest variance is associated with the macroscopic forms. The first flakes removed regardless of the action or the material worked were large scalar scars. Subsequent use tends to obliterate these scars with scars whose morphology reflects the relative hardness of the materials being worked (Tringham et al. 1974: 188).

The researchers observed a significant correlation between the edge angle or edge spine angle and the amount of damage. Generally the amount of damage is greater for more acute angles than with more obtuse angles for the same task (Tringham et al. 1974: 180). In spite of the amount of wear, the morphology of the utilization scars remained task-specific (Tringham et al. 1974: 180).

Another source of variation was the hardness of the material worked (Tringham et al. 1974: 188). On harder materials scarring was more rapid, scars were larger and deeper, and large hinged scars detached within the existing scalar scars and eventually obliterated them.

The grip used for the actions performed yielded variable results (Tringham et al. 1974: 182). Hand-held tools developed sharp-edged scalar scars, while wood hafted tools developed small almost vertical scars.

Striation morphology depends, among other things, on the nature of the artifact material, the shape of the abrasive particle, the amount of loading, and the degree to which the abrasive particle is fixed or free (Kamminga 1979: 148).

Some caution must be used in identifying striations. Del Bene (1979: 168) warns that "the poor depths of field and resolution inherent to the optical microscope create the illusion of striations" where none actually exist.

Additionally, the stresses in flake removal, either through core flaking or retouch, can yield linear configurations called lances (Cotterell and Kamminga 1979: 110). Lances are striation-like markings which are actually stepped or rib-like patterns of relief resulting during manufacturing and should not be mistaken for striations (Semenov 1964: 11-12; Cotterell and Kamminga 1979: 106-107).

Micropolishes are the least variable of the use-wear indicators. They vary only in their degree of development depending upon the amount of time that a tool was used (Keeley and Newcomber 1979). In the early stages of development some polishes, like those derived from working meat and fresh hide, antler and wood, as well as seasoned wood and bone, are virtually indistinguishable (Keeley 1977: 113; Keeley and Newcomber 1977: 39, 61). Also, the report of Keeley and Newcomber's blind experiment suggests that there is a range of variation in bone polishes (Keeley and Newcomber 1977: 61), but this range is not discussed.

There is also some evidence that the quality of the raw material used for the tools studied may generate difficulty in identifying discrete types of polish (Hayden 1979a: 193 comments by Keeley). This problem has not, however, been explored experimentally.

Additions to the Model

Through the course of the experiments presented in this paper, additional actions used but not defined in the literature had to be added to the model. Their definitions are this author's conception of the action. The first is pounding. Pounding is a percussive action similar in force to chopping. It differs from chopping in that the tool does not penetrate the material worked. The second is prying. Prying is a leverage motion in which the tool acts as a bar within the material being worked and in which one portion of the material acts as a fulcrum and another as the load. In this instance, prying was used while disarticulating joints.

In addition to the actions defined above, a new scale of relative hardness (Table 3) of materials was developed on the basis of the resistance provided by the materials used in the Truman experiments. This scale and not that provided in Table 2 was used in evaluating the blind test tools discussed in later sections. The table is presented here for convenience and clarity.

TABLE 3

Relative Hardness of Materials Used

Soft	Plant materials Meat Fresh hide Connective tissue Tanned hide
Medium	Grasses and other highly fibrous plants Combinations of hard and soft materials such as soil, plants growing in that soil and rock includions varying in size from sand grains to gravel
Hard	Bone Wood Antler Stone Hair Dried cane

TECHNIQUES EMPLOYED

All microscopic examinations of the tools made and used for this study were done with two Bausch and Lomb Stereo-Zoom 7 microscopes. One microscope was equipped with a Bausch and Lomb camera attachment and photo extension tubes. The photo extension tubes and camera were capable of duplicating the magnification of a 10X occular. This restricted its range to a minimum of 10X-70X and a maximum of 20X-140X with the addition of a 2X supplemental lens. The other microscope was equipped with an incident light attachment and had, with the addition of 15X occulars and a 2X supplemental lens, a maximum range of magnification from 30X to 210X. This microscope was used for detailed examinations of the tools after use.

At the upper limits of magnification, particularly with the addition of the 2X lens, both microscopes are subject to problems of depth of field and resolution like those described by Del Bene (1979: 168). All the tools were treated with an ink wash for photographing. For tools like flakes and other minimally retouched forms with relatively flat surface topographies, the addition of an ink wash is sufficient to counteract most of the resolution problems. Some examples of Burlington and Jefferson City cherts, through their own nature, create resolution problems which cannot be entirely solved.

Heavily retouched bifacial or unifacial tools present special depth of field problems both in terms of magnification and of photomicrographs. Their uneven topography creates a situation where the magnified area is rarely entirely in focus. This problem is particularly acute when photographing the tools. Photographs for this study cover magnifications ranging from 30X through 70X. Beyond this range the resulting photographs have both focused and unfocused areas of interest.

The choice of microscopes was dictated by availability. Even at their maximum magnifications of 210X, the microscopes are capable of only the lower end of the 120X-400X range at which Keeley (1977: 111) states that polishes are visible and distinguishable and are below the 300X and above range which he believes to be optimal for microwear studies (Keeley 1974: 324). This situation is expected to have some effect on the results of the experiments presented here.

METHODOLOGY

The methodology employed in this study was suggested by and substantially conforms to the systems suggested by Odell (1975, 1979), Keeley (1974), and Ahler (1971). The actual

method is described below. The described method is applicable both to the main body of the experiments and to the blind test.

The Tool Kit

The tool kits for both experiments are comprised of tool forms representative of the shape classes defined in the Harry S. Truman Archaeological Project Lithic Laboratory Procedures Manual and suggested by archeological examples from those collection. Examples of each tool form were made from the three most abundant chert types found in the reservoir area and in the artifact collections. All of the tools were made by Jack Ray according to generally accepted techniques of flint knapping. During manufacture, the tools were subject to incidental damage from falling among debris on the floor, platform preparation, percussion and pressure flaking with stone and antler implements and contact with protective leather pads (see Ray [Vol. II] for further details).

After manufacture, each tool was assigned a unique tool number, stored in individual plastic bags, and delivered to the investigators who were to use them.

Recording Procedures Prior to Use

Each tool was recorded macroscopically and microscopically before being used for a task. The pre-use macroscopic observations are designed to record existing macrowear damage arising from sources other than use. The pre-use microscopic observations are designed to record the unaltered character of the chert and the tools prior to use. The observations included features such as lances and microscarring, manufacturing or processing related polish, and the topography created by intentional retouch.

The macroscopic observations were made with the unaided eye or with a 10X hand lens. They were recorded as line drawings of the individual tools. The drawings were made by tracing the outline of each tool showing the dorsal face, the ventral face, and the cross section of the tool. Within these outlines, the existing macroscopic features were drawn freehand. The size, shape, orientation and placement of these features is substantially but not exactly correct. The greatest variance is in the size of the features. Except in rare instances, the intentional retouch scars, if any, on the tools were not included in the drawings. This was done for the sake of clarity. Therefore, many of these drawings represent a drastically simplified depiction of the actual situation.

Line drawings were chosen instead of photographs because photographs of entire tools were unable to capture the macro-traces due to the small size (1 mm or smaller) of the incidental damage and the subsequent use-wear damage and due to the confusion resulting from the intentional retouch.

Additionally, measurements were taken for each tool including maximum length, width and thickness and the edge angle of the projected area to be utilized.

The microscopic observations were made using a Bausch and Lomb Stereo-Zoom 7 microscope. Each tool was examined and an area suitable for its projected use was chosen. This area was designated by an india ink mark 2 to 3 mm from the edge. This was done so that the same area could be re-examined after use. Photomicrographs were then taken of these marked areas. For the majority of the tools the photomicrographs showed the dorsal and ventral faces of the same edge area. For tools such as gravers, perforators, and drills whose projected use included penetration into the material to be worked, the apex of the tip area was photographed. Additionally, one section of the side of the tip was also recorded. All tools were treated with an ink wash prior to being photographed.

Magnification for the photomicrographs was 30X and 50X. Previous work in this area by this investigator had indicated that these magnifications would yield clear, relatively detailed prints in virtually all instances.

A photographic log was kept for each exposure made. The log included the tool number, the area photographed, the light meter reading, the zoom setting, the length of the exposure, and any comments which were necessary.

After processing the tools were returned to their individual plastic bags and stored until they were used.

While precautions were taken to prevent incidental damage to the tools between the pre-use observations and recording and their subsequent use, it is likely that the processing itself and the subsequent storage added additional non-use related damage to the tools.

At the time that the observations and records were made, it was believed that any processing contact would be slight and short enough so as not to leave confusing traces. Post-use examinations, which will be discussed in detail in the following sections, indicate that this was not always the case.

Recording Procedures During Use

Detailed records were made as each tool was utilized. These included the tool number, the chert type, the tool's shape class, the mode of action utilized, whether or not the tool was hafted or whether any form of protective covering was used to protect the operator's hand and the material being worked. The area of the tool which was used was also recorded. This designation will be discussed in detail in the following subsection.

Observations were made during the course of the utilization regarding macroscopic damage as it was formed. This damage was described as it formed and as it appeared following continued use and additional damage, if any. Records were also made regarding damage caused by agencies other than use, such as contact with cutting boards or the dropping of the tool.

The duration of use was recorded primarily in minutes. In some instances, like the perforators used to pierce leather, a record was also made of the number of twists required to pierce the material and the number of holes produced during the working period. Only the time the tool and material were in contact was counted in calculating the duration of tool use.

At this stage, only macroscopic observations were made. Occasionally a tool would be examined under the microscope. These observations were only tentative because of the relative lack of comparative data before the entire experimental series was completed. These observations were not recorded.

Procedure for Designating Used Areas of the Tool

Procedures for designating the area of the tools used are discussed here in detail because they vary substantially from those recommended by Odell (1975, 1979) and Ahler (1971). These procedures are an outgrowth of similar designations outlined in the Lithic Laboratory Procedures Manual and offer greater specificity in delineating the areas used.

Designations of area are always given with the dorsal surface of the tool facing the investigator. There is a three level hierarchy for determining which surface is the dorsal surface. For flakes and tools retaining a bulb of percussion, the dorsal face is always the face opposite the bulb (Fig. 1). For tools without a bulb of percussion, the procedure is more arbitrary. For tools without bulbs of percussion but where the curvature of both surfaces is approximately equal, the dorsal face is arbitrarily designated as the face with the tool number (Fig. 2a, a'). In cross-section, the dorsal face is always marked with a capital D.

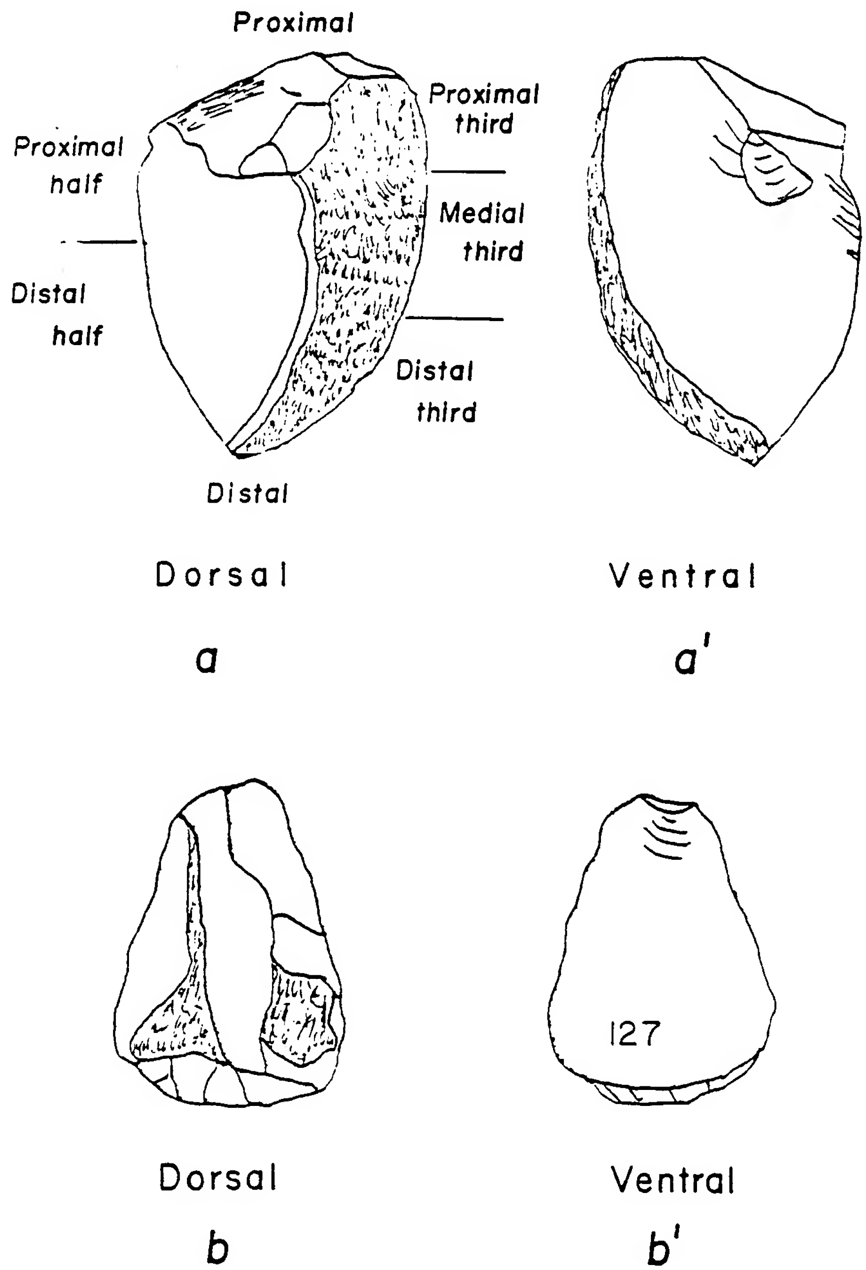

Figure 1. Orientation of tools having bulbs of percussion.

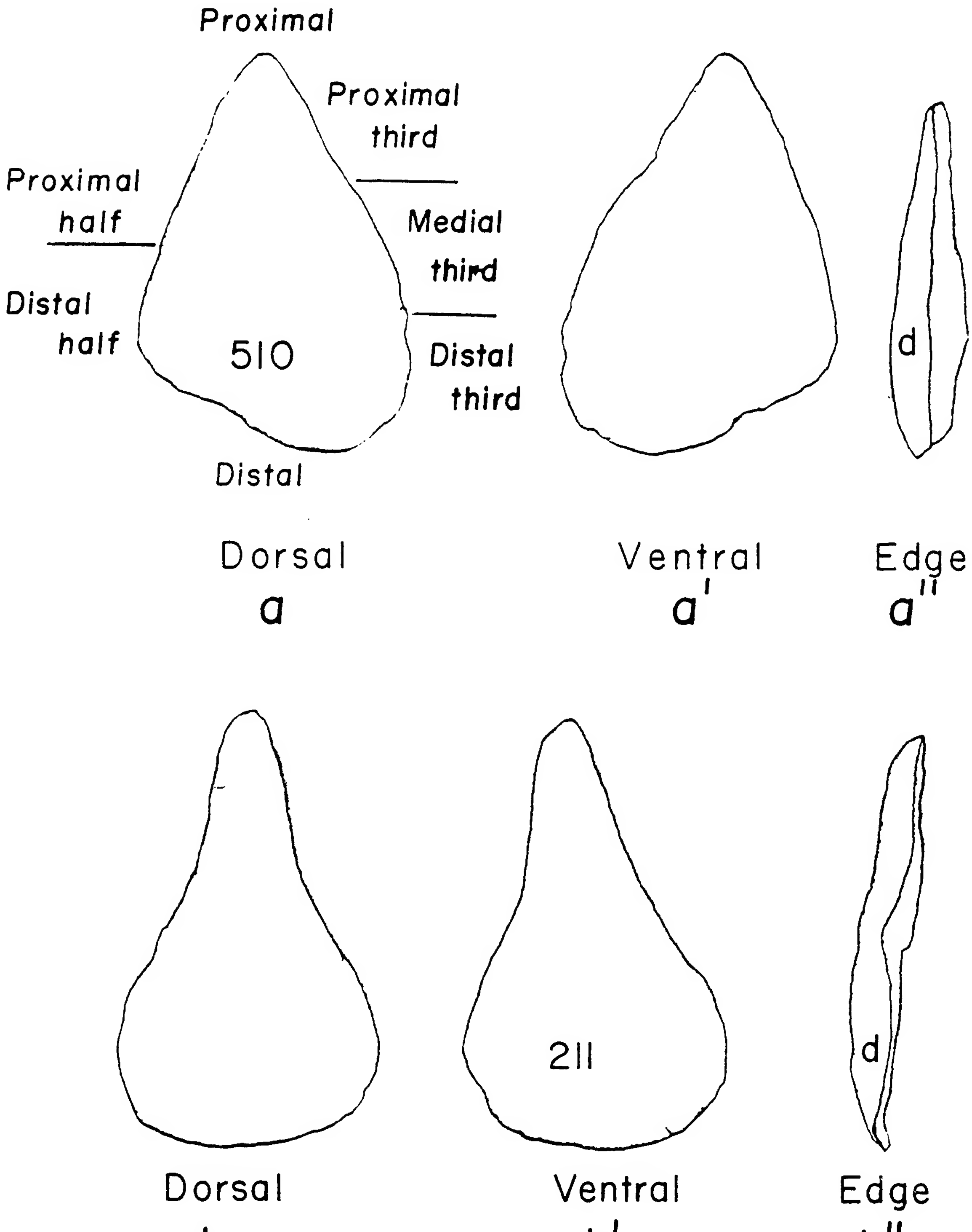

Figure 2. Orientation of tools without bulbs of percussion but having clearly defined distal and proximal ends.

For tools without a bulb of percussion where the curvature of the surfaces is unequal, the most highly ridged or domed surface is arbitrarily the dorsal surface regardless of the position of the tool number (Fig. 2b, b'; Fig. 3). Bulbs always take precedence over the other indicators. Ridges and domes take precedence over the position of the number.

Proximal and distal ends are similarly determined. For tools with bulbs of percussion, the proximal end is always the bulbar end and the distal end is always the end opposite the bulb (Fig. 1a). For tools without bulbs of percussion but which have one end narrower than the other, the narrow or pointed end is the proximal end and the wider end is the distal end (Fig. 2a). For amorphously shaped tools without bulbs of percussion, the symbol $\perp$ is used to designate the distal end. The distal end is that end closest to the horizontal bar of the symbol (Fig. 3). The symbol is always placed on the dorsal face. For tools such as gravers, perforators, and drills, the term tip is used to refer to the projection which was actually used.

Utilized areas on the lateral edges of all tools are designated in the same manner. Right and left lateral edges are those with the proximal end at the top (Figs. 1a and 2a). The portion of the lateral edge utilized is expressed in wholes (left lateral edge), halves (proximal half left lateral edge), or thirds (medial third right lateral edge; Figs. 1a, 2a). If the extreme distal end is utilized, the area is termed distal end (Figs. 1b, b'). If the extreme proximal end is utilized, it is termed proximal end (Figs. 2b, b').

Recording Procedures After Use

As noted above, the majority of the observations regarding macroscopic damage were made while the tools were being used. After use, the use related damage was superimposed on selected original pre-use line drawings. The post-use damage was recorded in red ink. Figures 4 through 16 (see the sections on results) are a result of this procedure. All tools were not treated in this manner due to time constraints.

Microscopic observations were made on all utilized tools after use. These observations were made using the Bausch and Lomb incident light microscope. Generally the magnification used was 105X; under special circumstances magnifications of 90X and 210X were also used. These observations were made without coating the chert surface with ink. Notes were taken on the observations including the tool number, the chert type, the mode of action, the material worked, the area surveyed, the forms of damage observed, and the distribution of that damage. The use-wear damage included polishes,

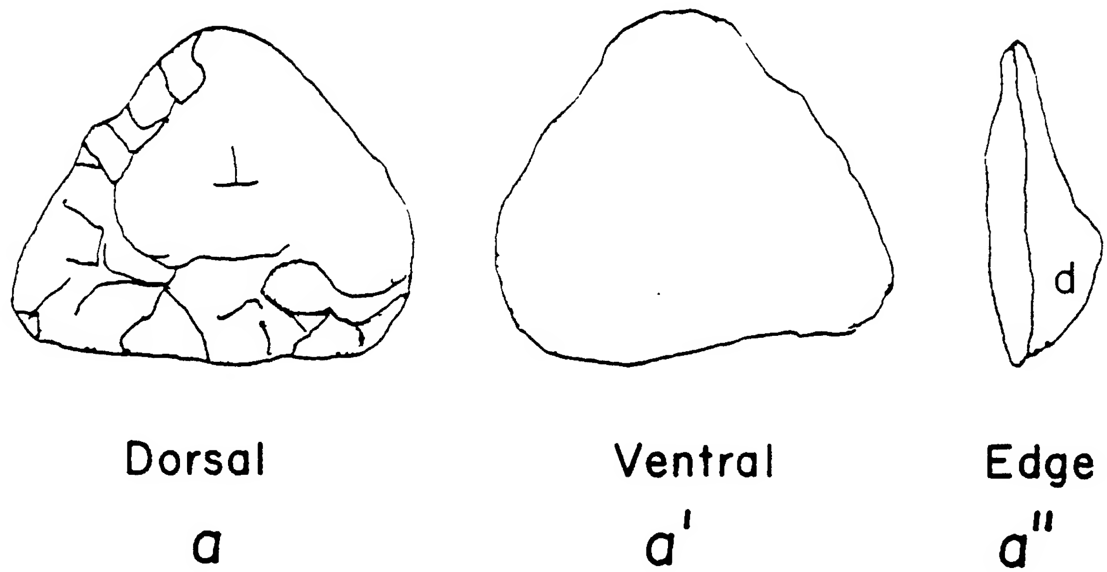

Figure 3. Orientation of tools without bulbs of percussion or clearly defined distal and proximal ends.

both identifiable and unidentifiable, striations and microscopic forms of fracturing and related edge damage. The absence of damage forms was also observed. The notes included the magnification and light level at which the observations were made as well as recommendations regarding photographs.

Selected tools which showed the best examples of the wear patterns and the problems encountered in the observations were photographed. Magnifications in this instance were higher (70X) than those for the pre-use photomicrographs. This was done primarily for differentiating the various polishes. Photomicrographs were also taken at 40X for more direct comparison with the pre-use photos. These are not presented in this report because of their inability to depict distinguishable polishes. Plates 1 through 4 (see the sections on results) show examples of both the pre- and post-use photomicrographs.

Experimental Controls

RAW MATERIAL

The first experimental tool kit includes a full range of tool forms made from the three most common chert types in the area and in the archeological collections. These chert types, in descending order of representation, are Jefferson City, Burlington, and Chouteau (Ray, this volume).

Although there is a substantial range of variation in each type, they generally differ in gross morphological characteristics such as grain size and flaking characteristics (Ray, this volume). Of the examples used for the type collection, Chouteau exhibits the smallest grain size and the greatest degree of brittleness; Burlington has the largest grain size and least ease of flakability; Jefferson City lies between these extremes. (See Ray, this volume, for a more detailed description of the stone characteristics.) It should be noted, however, that the Chouteau used here is of exceptional quality both in terms of the raw material available in the reservoir area and in terms of the collections. In an overall sense, Jefferson City is the finest grained of the three most abundant cherts with Chouteau and Burlington following in descending order. This is reflected in Jefferson City's representation in the Truman collections. Analysis of the lithic collections suggests that Jefferson City was often the preferred chert.

The inclusion of a full range of tool forms in the three chert types is designed to control for possible variation in the use-wear traces stemming from the character of the raw material.

The second experimental tool kit was produced entirely from Jefferson City chert. This was done because of its abundance in the archeological collections and in the knapper's raw material collection.

TOOL FORM

The tool forms represented in the experimental samples were suggested by those found in the artifact collections and defined according to the Lithic Laboratory Procedures Manual. The range of forms included unmodified or backed flakes, bifaces (including points or other bifacial forms), denticulates, spokeshaves, scraper planes, end-, side-, or general-scrapers, drills, perforators, gravers, axes, adzes, hoes, cleavers, wedges, and an abrader (a sandstone slab). This selection insures that use-wear patterns on flakes from the pertinent cherts can be compared to those expected from the model, that both bifacially and unifacially retouched forms can be compared to the model and the Truman flakes, and that use-wear patterns for each tool form found in the Truman collections will be generated.

INCIDENTAL DAMAGE

As noted in the preceding sections dealing with the recording procedures, both before-use and after-use records were made of incidental damage from manufacturing and processing the experimental tools and the interplay of that damage with the subsequent use-wear damage. This procedure precludes mistaking manufacturing damage for use-wear and facilitates an evaluation of an investigator's ability to distinguish the two on tools of unknown use.

MODES OF ACTION

The modes of action set forth in the model were strictly applied to all tools used regardless of the tool form. This enables the investigator to both compare the results with the model and to determine whether or not similar distributions of wear occur on retouched forms. Some tools were used for multiple actions in order to control for such a contingency in archeological samples.

MATERIALS UTILIZED

Although the range of materials worked was suggested by the model, those actually processed were more varied. They included hair, fresh hide, tanned hide, meat, bone, connective tissue, and ligaments, bark and seasoned wood, grasses, Jerusalem artichokes, dry cane, antler, shell, soil, roots, and stone. This was done in order to duplicate the traces described in the model and to account for variation,

if any, in the use-wear traces produced by grasses as opposed to tubers or by wood as opposed to dry cane.

CAUTIONARY NOTE

Not all potential actions were performed with each available tool form on each material utilized. Some subjective decisions regarding tool task fitness were made. The impact of this subjectivity is lessened by two factors. First, an attempt was made to use both retouched and unretouched examples for each task. This should control for the different fracturing properties of the two-edge types. Second, the comprehensive use-wear specialists agree that the presence of two or more corroborating types of use-wear patterns must be present in order to establish utilization for an action on a material (Semenov 1964: 16-21; Keeley and Newcomber 1977: 37). Therefore, if the differential wear formation expected for retouched examples is controlled and if two or more diagnostic wear patterns can be ascertained, then both expected and unexpected uses can be determined for a particular tool form.

THE EXPERIMENTS

The following sections of this paper describe replicative experiments carried out as a test of the applicability of use-wear analysis as a descriptive technique for use with the chipped stone artifact collection from the Truman Reservoir area.

This test rests on the production, utilization, analysis, description, and comparison of two sets of experimental tools of known use on known materials. The first set is the province of this investigator. It is designed to fulfill a number of purposes. First, it can act to verify the diagnostic use-wear features reported in the literature and summarized in Tables 1 and 2. Second, if its results so indicate, it can act to expand or amend those diagnostic features. By doing these two things, the first experimental collection can serve both as a partial basis for evaluating the utility of use-wear analysis; and if it does prove useful for that purpose, it can serve as a guide or type collection for the description of those collections.

The second set of experimental tools is the base for a "blind test" similar to those reported in the literature (Keeley and Newcomber 1977; Newcomber and Keeley 1979; Odell 1980). In accord with the rules established by the reported blind tests, the second set of tools was produced and utilized independently of this investigator and then submitted for analysis and interpretation using the previously processed type collection. As in Newcomber and Keeley's (1977) experiments, this procedure is designed to test this

investigator's accuracy in correctly identifying use-wear traces. This test is designed to set confidence limits on any subsequent interpretation of Truman artifactual specimens by this investigator.

The First Experimental Series

The first set of experiments was designed around activity sets suggested by the comprehensive experiments (Semenov 1964; Tringham et al. 1974; Keeley and Newcomber 1977; Newcomber and Keeley 1979). The activity sets include butchering, fresh hide processing, tanned hide processing, plant processing, soil moving, wood bone and antler working, splitting cane for hafting elements, and graving designs on clam shells.

Within the framework of the activity set, individual tasks were performed. These tasks utilized the strictly defined actions summarized in Table 1 of the model. Generally, each tool was used for a single action on a single material. For some tasks, especially those associated with butchering and fresh hide processing, a single tool was sometimes used for two or more actions either on a single material or on several materials. This was done in order to control for the likelihood of archeological examples of multipurpose tools.

The first five columns of Table 4 in the section dealing with the results of the first experiments summarize the tasks performed in each activity set including the task or function, the tool number, its chert type and shape class or form, the action performed and the material processed. No attempt was made to recreate known or hypothesized aboriginal processing techniques. Such duplication lay beyond the expertise and experience of the experimenters involved. Additionally, while the relative efficiency of a tool form in the opinion of the experimenter was noted, no attempt was made to systematically test tool efficiency.

The "Blind Test"

As noted above, the tools for the "blind test" were chosen and produced without this investigator's knowledge. As in the first experiment, the tool forms were suggested by those commonly found in the Truman collections. The composition of the actual tool kit was determined by the Director and Assistant Director of the Truman Project. The tools were produced by Jack Ray and delivered by him in a closed carton to the investigators who were to record them pre-use and to use them.

The tasks actually performed were chosen by the independent investigators. Before those tasks were performed,

the investigators were briefed regarding recording procedures, controls, and the model. They were given a copy of the activity set, tasks, tool forms, materials, and actions projected for the first experimental series. They were asked to use the projections as a guide for their experiments, but they were not limited to those projections. The only restrictions placed on the "blind test" experiments were requests that only some of the tools should be used for multipurposes and/or materials and that the tasks performed be ones that could reasonably have occurred in the reservoir area during the time in question. This investigator was not present during any of the blind test experiments. The tools were cleaned and delivered to this investigator in miscellaneous order. The notes and preuse records were delivered at the same time in a separate closed container. This investigator did not see these papers until after the blind test tools had been analyzed and identified using the first experimental series as a guide. Table 5, presented in the following section regarding the results of the blind experiment, shows the uses to which those tools were put.

Paper Bag "Wear" Experiment

Incidental to the two part experimental series described above, an experiment designed to test the effect of storing archeological collections in paper bags was also conducted. This investigator hypothesized that since brown paper bags are made from wood pulp, their use as storage containers for artifacts which had been transported several times over a number of years could produce a polish similar to the wood polish defined by Keeley and presented in Table 2 above.

The experiment involved two Jefferson City flakes drawn from the blind test tool kit. One flake was placed in a brown paper bag of the same type used for storing the Truman lithic artifacts. The bag was then carried down three flights of stairs and placed on a table. It was moved around on the table several times over the course of a month and was then moved upstairs to a different office. This tool remained in the bag for approximately three months.

The second tool was rubbed with a paper bag for 10 minutes and then stored in another bag for approximately three months.

These tools had no counterparts in the first experimental series and, therefore, were not treated as part of the blind test. At the time they were analyzed, this investigator knew their history. Unaltered Jefferson City chert from the same source as the tools was used for comparison in assessing the results of the experiment.

THE RESULTS OF THE FIRST EXPERIMENTAL SERIES

The following is a presentation of the results of the first experimental series. Table 4 is a summary of the experiments performed and of the macroscopic and microscopic use-wear damage observed after the various tasks were completed. It is presented here for the reader's information and reference in regard to the discussion of the results presented in the following sections.

The information recorded in the macroscopic damage column is a result of notes taken during the use of some of the tools and of generalized observations of the tools on which such notes did not reflect damage during use. They are not based on the pre- and post-use comparative line drawings. Therefore, in some instances a tool will be listed as having no definite use related damage, when the drawings suggest the presence of some use related scarring.

This technique was chosen because of the confusion of scars from production and use which will be discussed below and because an investigator dealing with archeological collections would not have the benefit of such pre-use records in assessing the traces observed on artifacts.

The polish descriptions given in the microscopic damage column are wholly the creation of this author. They are based on this author's observations which were made without reference to the polish descriptions presented in Table 2. This was done because the first experimental series is a test of the applicability of the applicability of the model to the tools in this series. Reference to Table 2 could have influenced the observations leading to the observer's seeing likenesses or difference where they did not in fact exist.

The shape classes used in Table 4 are generally those from the Lithic Laboratory Procedures Manual; however, in some instances they have been simplified. For example, all scraper types e.g., end scrapers, side scrapers, and general scrapers are all classed as scrapers for purposes of Table 4. This is done because the placement of the working edge on the circumference of the tool has no bearing on the results of this experimental series. The same is true for spokeshaves, flakes and bifaces.

In some instances experiments in the first series yielded forms of use-wear which were not defined in the model. The following are terms and definitions used to describe these forms.

An abrupt break is as its name implies a clean break leaving a flat surface with acute unscarred edges. It is

TABLE 4

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
Slicing Meat	518	Chouteau	Flake	Cutting	Meat	Medial and distal thirds of left lateral edge	5	No definite use related damage	Dorsal-2 areas of bright lustrous polish which fills depressions within 1 mm of edge. Polish is not well developed. Microscopic scars are mainly snap scars although 2 large scalar scars occurred. Ventral-1 area of well developed polish; snap scars accompanied by some crushing and smoothing.
	155	Jefferson City	Flake	Cutting	Meat	Left lateral edge	5	No obvious use related damage	Dorsal-no polish; no striations minor crushing with 3 large scalar scars. Ventral-no polish; no striations; no crushing. 2 scalar and 1 complex scar. 1 finger print on backed portion of tool.
	503	Chouteau	Biface	Cutting	Meat	Proximal and medial thirds of left lateral edge	5	No obvious use related damage	Dorsal-no polish; no striations slight dulling; no crushing or rounding. Scarring complex and probably result of manufacture rather than use. Utilized Edge-Slight polish development looks like luminous dots has greasy, matte appearance. No scarring that is definitely due to use.
	290	Jefferson City	Biface	Cutting	Meat	Proximal half left lateral edge	5	No definite ι related damage	Dorsal-very slight dulling of edge not materially different than unused areas. 2 scalar scars may be the result of use. 1 small area of greasy matte polish. Polish occurs in a highly crystalline area. Ventral-no polish no striations no definite use related scarring. With the addition of 2X supplemental lens, 1 area of very poorly developed polish was visible.
Slitting hide from hair side in preparation for skinning animal	230	Jefferson City	Flake	Cutting	Hide Hair Meat Contact	Proximal half of left lateral edge	2	No definite use related damage	Dorsal-no polish; slight crushing of edge. Discontinuous groups of scalar scars along length of utilized portion. Ventral-1 set of faint striations slight blunting of edge. Discontinuous groups of scalar scars. Distribution consistent with cutting.
Skinning animal	281	Jefferson City	Biface	Cutting	Connective tissue and meat	Proximal and medial thirds of right lateral edge	3	No definite use related damage	Dorsal-slight blunting of edge with slight crushing of some projections. No scars definitely the result of use.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
Splitting bone	207	Jefferson City	Wedge	Chopping	Bone	Left lateral edge	2	Crushing of edge with some complex terminated scarring	Edge-major crushing. Original grayish translucent stone is opaque white and powdered post use. No polish; no use related scarring.
Pounding wedge to force it through bone	232	Jefferson City	Hammer stone	Pounding	Stone	Area around within ink square	2	Crushing on surface	Crushed areas accompanied with white powdery debris. Crushing not extensive.
Graving fresh bone	815	Burlington	Graver	Two-way graving	Bone	Pointed tip on left corner of distal end	5	Obvious reduction of point accompanied by smoothing and rounding	Tip-some polish. Polish looks like clusters of lustrous white dots.
	516	Chouteau	Graver	Two-way graving	Bone	Pointed tip on proximal end	5	Obvious reduction of point accompanied by smoothing and rounding	Tip-crushing with white powdery debris. Tip rough and broken but showing no recognizable scars.
	205	Jefferson City	Graver	Two-way graving	Bone	Pointed tip on right corner of distal end	2	Tip broke off immediately; continued use yielded obvious attrition with smoothing and rounding	Tip-2 parallel striations across face of tip. Polish inside the striations. Polish looks like clusters of lustrous white dots.
	206	Jefferson City	Graver	One-way Graving	Bone	Pointed tip on right corner of distal end	2	Tip broke immediately; continued use produced obvious attrition of tip	Tip-no polish; tip heavily fractured. Fracturing complex leaving a rough crushed surface.
Whittling bone	731	Burlington	Spokeshave	Transverse cutting	Bone	Concavity in proximal half of right lateral edge	5	Large complex scars in center of dorsal concave area	Dorsal-No polish, no striations, no micro scarring. Ventral-crushing with white powdery debris One tiny area of poorly developed polish.
	533	Chouteau	Spokeshave	Transverse cutting	Bone	Concavity in distal end	5	Dorsal-crushing with white powdery debris. Ventral-obvious attrition and large scalar scars	Dorsal-polish around entire convex area. Polish looks like clusters of luminous white dots. Edge crushed with white powdery debris No definitely use related scarring. Ventral-polish like clusters of white luminous dots. Polish does not appear inside large scalar scars.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	208	Jefferson City	Spokeshave	Transverse cutting	Bone	Concavity in medial third of right lateral edge	5	No definite use related scarring.	Dorsal-slight poorly developed polish which looks like clusters of luminous white dots. Crushing with white powdery debris. No definitely use related scarring. Ventral-slight poorly developed polish which looks like white luminous dots. Crushing with white powdery debris in central part of convex area.
Sawing bone	810	Burlington	Denticulate	Sawing	Bone	Center portion of distal end	5	Complex terminated scars virtually indistinguishable from retouch and related manufacturing scarring.	Edge-no polish; no striations complex scarring. Crushing with white powdery debris.
	526	Chouteau	Denticulate	Sawing	Bone	Center section of distal end	5	Crushing on projections	Edge-a few patches of polish development. Polish resembles clusters of luminous white dots. Crushing and smoothing of projections accompanied by white powdery debris.
	203	Jefferson City	Denticulate	Sawing	Bone	Medial third of right lateral edge	2	No definite use related damage	Edge-very slight polish development. Polish looks like clusters of luminous white dots. Very slight crushing with minimal white powdery debris.
	703	Burlington	Biface	Sawing	Bone	Proximal half of left lateral edge	5	No definite use related damage	Edge-no striations; no clear scarring. Some crushing and crumbling breakage accompanied by white powdery debris. Slight poorly developed polish. Polish looks like luminous white dots.
	512	Chouteau	Biface	Sawing	Bone	Proximal and medial thirds of left lateral edge	5	Crushing with white powdery debris within 1 mm of edge on both faces	Faces-no identifiable scarring and no polish on either the dorsal or ventral portions of the tool. Edge-slight polish, looks like luminous white dots. Crushing and slight smoothing accompanied by white powdery debris.
	275	Jefferson City	Biface	Sawing	Bone	Proximal and medial thirds of right lateral edge	5	No definite use related damage	Edge-very slight poorly developed polish. Slight crushing with minimal white powdery debris.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
Scrape flesh from bone	529	Chouteau	Scraper	Transverse cutting	Bone, meat connective tissue	Distal end	5	Ventral-5 large scalar scars formed mid way through use	Dorsal-slight polish within 1 mm of edge. Polish looks like white luminous dots. Complex fracturing. Ventral-slight polish which looks like white luminous dots. 3 step-terminated scalar scars, 1 distinct feather terminated scar. No polish in scars.
	127	Jefferson City	Scraper	Transverse cutting	Bone, meat connective tissue	Distal end	5	No definite use related damage	Dorsal-some poorly developed polish. Complex fracturing on edge. Ventral-very fine band of polish along entire working edge. Polish looks like luminous white dots. 1 possible striation on polished surface.
Disarticulating joints	523	Chouteau	Flake	Cutting	Meat primarily, connective tissue ligaments some bone contact	Medial third of right lateral edge	2	Ventral-deep striation like features. These are lances; not use-wear damage	Dorsal-some polish, faint with greasy matte luster. A few fine striations running at a 5° to 10° angle from edge. Ventral-polish with greasy matte luster. Striations running at a 5° to 10° angle from edge. Edge-no identifiable scar types. Edge appears slightly rough.
	151	Jefferson City	Flake	Cutting sawing prying	Meat, ligament, bone	Medial and distal thirds of right lateral edge	3	No definite use related damage	Dorsal-slight poorly developed polish appears to be of two types-greasy matte and luminous white dots. Small to tiny scars, majority are snap scars, some are scalar. Ventral-no polish. Striations-both sleeks and furrows Small scalar scars distribution consistent with cutting.
	847	Burlington	Biface	Cutting sawing	Meat, ligaments, some bone contact	Proximal half of left lateral edge	3	No definite use related damage	Edge-crushing and blunting of projections. Complex fracturing, some slight polish which appears to be bone polish (lustrous white dots) but is not clear enough to be certain.
	506	Chouteau	Biface	Cutting	Meat, some bone and ligament contact	Proximal and medial thirds of left lateral edge	5	No definite use related damage	Edge-Crushing and blunting of projections. Complex fracturing with white powdery debris. Some slight polish; not well enough developed to identify.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	202	Jefferson City	Cleaver	Cutting	Hide with hair meat, ligaments, some bone contact	Distal end	2	No definite use related damage	Edge-major crushing with white powdery debris. No polish, no striations. Complex fracturing which may be an artifact of production or may be a product of both use and manufacture.
Multi-function	277	Jefferson City	Biface	Cutting sawing prying	Hide with hair, meat ligaments bone	Proximal half of left lateral edge	3	No definite use related damage	Edge-very slight polish,not identifiable. Crushing of projections accompanied by white powdery debris. Some striations along projections. They show lateral movement but not the type of stroke.
Dismembering carcass by chopping through bone below joint	802	Burlington	Cleaver	Chopping	Bone	Distal end	3	Some visible crushing on projections	Edge-crushing with white powdery debris. No polish, no striations, no definitely use related scarring
Scraping flesh from hide	808	Burlington	Biface	Transverse cutting	Fresh hide meat	Distal third right lateral edge and distal end	10	No definite use related damage	Edge-minor crushing of projections accompanied by minimal amounts of white powdery debris. Very slight polish development. Polish has a matte finish like meat polish.
	279	Jefferson City	Biface	Transverse cutting	Fresh hide meat	Right half of distal end	20	No definite use related damage	Edge-minor crushing of edge and surface accompanied by white powdery debris. The crushing tends to follow the direction of the stroke. Some isolated areas of dull matte polish.
	530	Chouteau	Scraper	Transverse cutting	Fresh hide meat	Distal end	20	No definite use related damage	Dorsal-minor crushing with white powdery debris. Complex fracturing well developed dull matte polish. Ventral-no polish, crushing or use related scarring.
	129	Jefferson City	Scraper	Transverse cutting	Fresh hide meat	Distal third of right lateral edge and right half of distal end	20	2 large scalar scars observed after tool hit carpet tack twice	Edge-heavily crushed with white powdery debris. Complex fracturing, may be artifact of production A few patches of dull matte polish
Cutting and scraping flesh from hide	505	Chouteau	Biface	Cutting and transverse cutting	Fresh hide meat	Proximal third of left lateral edge	15	No definite use related damage	Edge-crushing with white powdery debris. Isolated areas of dull matte polish on edge and surface.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
135	135	Jefferson City	Scraper	Cutting and transverse cutting	Fresh hide meat	Distal end	15	Obvious edge dulling and rounding	Working face edge-minor crushing with white powdery debris. Complex fracturing. Some weak polish development. Ventral surface-edge blunted. Dull matte polish over entire surface near edge.
	738	Burlington	Flake	Cutting and transverse cutting	Fresh hide meat	Medial and distal thirds of right lateral edge	20	No definite use related damage	Dorsal-primarily complex scarring with some scalar scars. Very slight poorly developed polish. Ventral-primarily complex scarring with some scalar and snap scars. Face is generally crushed but without debris.
	740	Burlington	Flake	Cutting and transverse cutting	Fresh hide meat	Medial and distal thirds of right lateral edge	60	Obvious dulling and rounding of edge	Dorsal-no polish and striations. Edge crushed with many small scalar scars. A few complex scars at retouched corner. Ventral-slight crushing of edge and face. Some weak polish development on edge. Many quartz inclusions which can be mistaken for polish.
	564	Chouteau	Flake	Cutting and transverse cutting	Fresh hide meat	Medial and distal thirds of right lateral edge	20	No definite age related damage	Dorsal-medium crushing accompanied by white powdery debris. Debris run parallel to edge. Small scalar scars whose distribution is consistent with cutting. Ventral-minor crushing with white powdery debris. Crushed areas show some directionality. They tend to run at a 30° to 40° angle to the edge. There are many small scalar scars along the entire edge.
	150	Jefferson City	Flake	Cutting and transverse cutting	Fresh hide meat	Medial and distal thirds of left lateral edge	15	No definite use related damage	Dorsal-large scalar scars with minor crushing of edge and surface. Ventral- light crushing on edge and surface. Some small and a few large scalar scars.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	229	Jefferson City	Flake	Cutting and transverse cutting	Fresh hide meat	Medial and distal thirds of left lateral edge	30	Edge roughened; many tiny snap scars	Dorsal-edge and surface crushed; crushing is directional, lies at a 20^{o} angle to edge. Some scalar scars at proximal end of edge. Faint poorly developed polish. Ventral-complex scarring; distribution consistent with cutting. Striations and directional polish at 20^{o} angle from edge.
	739	Burlington	Flake	Cutting and transverse cutting	Fresh hide plastic	Medial and distal thirds of left lateral edge	10	No definite use related damage	Dorsal-edge blunted with a few small scalar scars. Slight poorly developed polish. Ventral-edge rounded and crushed. Some complex scarring around lances.
	507	Chouteau	Biface	Transverse cutting	Fresh hide plywood	Distal end	5	No definite use related damage	Edge-crushing accompanied by white powdery debris. Some isolated areas of dull matte polish. Ventral surface-1 area of well developed polish. Appears to be a finger print.
Piercing tanned hide without twisting tool	818	Burlington	Perforator	Piercing	Tanned hide	Pointed tip of distal end	0.10	Tip broke during first attempt. Left flat triangular tip unfit for further use	Tip-clean break. No polish, no striations, no other scarring.
	554	Chouteau	Perforator	Piercing	Tanned hide	Pointed tip of distal end	20	No definitely use related damage	Tip-rough uneven fracturing, no identifiable scar type. Polish on projections only looks like a dull sheen. Sides of tip-well developed polish on unretouched area. On retouched area, crushing with white powdery debris, minor polish development. It is impossible to distinguish use related and incidental scarring.
	218	Jefferson City	Perforator	Piercing	Tanned hide	Pointed tip of distal end	2	Tool tip too blunt to penetrate hide. Work suspended after 20 attempts.	Tip-slight crushing, no polish.
Piercing holes in tanned hide by twisting tool	819	Burlington	Perforator	Piercing with twist	Tanned hide	Pointed tip of distal end	20	During first three minutes of work tip fractured repeatedly leaving small and medium scalar	Tip-slight crushing, faint polish. Characteristics could not be determined due to poor resolution. Dorsal-isolated areas of indeterminate polish. No striations, no

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
								scars. Continued use erased some of these scars and smoothed and rounded the tip.	use related damage.
	553	Chouteau	Perforator	Piercing with twist	Tanned hide	Pointed tip of distal end	19	No damage until the last hole. At that time a large portion of the ventral surface of the tip hinged off.	Tip-crushing with white powdery debris. No polish, no striations. Ventral side of tip-polish looks like dull sheen; no striations area,not retouched. Dorsal spine and edges-area retouched; slight crushing with white powdery debris. Some polish; complex scars.
	219	Jefferson City	Perforator	Piercing with twist	Tanned hide	Pointed tip of distal end	20	After four minutes of use tip shattered. It continued to shatter until a large scalar scar was removed by use. This removal acted to resharpen the tool and use continued. Although its appearance did not change the tool became progressively duller.	Tip-crushing accompanied by white powdery debris. Minimal polish development on projections. Ventral surface of tip-area unretouched. Surface uneven; minimal polish on projections. Dorsal spine-retouched. Crushing with white powdery debris; complex scarring; minimal polish development on projections.
Reaping grasses	804	Burlington	Biface	Cutting	Grasses	Medial and proximal thirds of right lateral edge	20	No obvious use related damage.	Edge-slight rounding, faint polish, complex scarring, some crushing on projections. Dorsal and ventral faces-smoothed but not polished.
	504	Chouteau	Biface	Cutting	Grasses	Medial and proximal thirds of right lateral edge	20	Small projections worn away, 2 large and 2 medium snap scars on working edge.	Edge-complex fracturing crushing accompanied by white powdery debris; some rounding and polish. Ventral-complex fracturing and polish. Polish is very bright and appears fluid.
	276	Jefferson City	Biface	Cutting	Grasses	Medial and proximal thirds of right lateral edge	20	Small projections worn away; tool surface smoothed. Beginning of polish visible.	Edge-complex fracturing; slight rounding, slight polish along entire working edge. Polish is bright and fluid. Dorsal surface-resolution is poor; no polish visible.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	846	Burlington	Flake	Cutting	Grasses	Medial third of left lateral edge	20	Small snap scars along entire edge. Alternating groups of small scalar scars distribution is consistent with cutting.	Dorsal-large and small scalar scars; some crushing of edge and surface; no polish; no striations. Ventral-some crushing of edge; some small scalar scars.
	565	Chouteau	Flake	Cutting	Grasses	Proximal and medial thirds of right lateral edge	20	1 area of complex overlapping scars of a variety of shapes. No obvious alteration of remainder of edge. Faint sheen on working edge; edge feels but does not look rounded.	Dorsal-resolution poor; no polish some scalar scarring; some crushing, some rounding. Ventral-1 area of weak polish development; scalar scarring distribution of dorsal and ventral consistent with cutting.
	228	Jefferson City	Flake	Cutting	Grasses	Distal half of left lateral edge	20	Minor observable damage; some small snap scars; some small scalar scars primarily on dorsal but also alternating on ventral. Distribution consistent with cutting.	Dorsal-some crushing accompanied by white powdery debris. Some rounding mainly stepped complex scarring with a few isolated scalar scars. Ventral-crushing on edge and surface. Edge rounded. Tiny scalar scars; distribution of scars on dorsal and ventral surfaces is consistent with cutting.
Peeling and slicing tubers	848	Burlington	Flake	Cutting	Jerusalem artichoke cut on Formica cutting board	Medial third of left lateral edge	20	Edge reduction due to wearing away of stone rather than flake removal. Little tool-cutting board contact.	Dorsal-major edge crushing with a few scalar and snap scars. Very slight polish development; resolution poor. Ventral-edge crushing and many areas of overlapping scalar scars. Polish weak, resolution poor.
	569	Chouteau	Flake	Cutting	Jerusalem artichoke cut on Formica cutting board	Medial third of left lateral edge	12	Closely spaced mass of striation like markings on ventral face run at 40° to 45° angle from edge. Little tool-cutting board contact.	Dorsal-polish not well developed but covers entire surface. Some scalar scars; no polish on scar interiors. Ventral-striations running at 40° to 45° angles from edge appear to be result of crushing. Minor polish, not as well developed as that on the dorsal face.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	241	Jefferson City	Flake	Cutting	Jerusalem artichoke cut on a Formica cutting board	Proximal half of left lateral edge	16	Groups of small scalar scars alternating from dorsal to ventral faces. Dist 'bution is consistent with cutting. 1 small snap scar resulted from tool hitting cutting board.	Dorsal-a few scalar scars. Linear areas of polish; polish is bright but does not appear fluid. Ventral-Tiny scalar scars along entire working edge, some snap scars also. Medium crushing; some areas of well developed polish which appear bright and fluid; polish follows natural topography of chert.
	856	Burlington	Biface	Cutting	Jerusalem artichoke cut on a Formica cutting board	Distal half of left lateral edge	9	No use related damage observed. Light tool-cutting board contact.	Edge-blunted and slightly rounded. Slight polish development; polish is bright.
	540	Chouteau	Biface	Cutting	Jerusalem artichoke cut on a Formica cutting board	Proximal and medial thirds of right lateral edge	16	No obvious use related damage observed. Some hard tool-cutting board contact.	Edge-slight crushing and rounding. Some minor polish development. Edge highly fractured; scarring is complex.
	274	Jefferson City	Biface	Cutting and sawing	Jerusalem artichoke cut on a Formica cutting board	Medial and proximal thirds of right lateral edge	20	No obvious use related damage observed. Tool seemed to be getting dull during last 7 minutes of use.	Edge-complex scarring may be artifact of production. Weak poorly developed polish; same polish continues on dorsal face.
Soil moving	824	Burlington	Hoe	Chopping	Soil, grass roots, misc. rock	Distal end	20	Smoothing of edge; some battered areas with complex scarring. A faint sheen was observed on the working edge and on the area held in a gloved hand. The sheen was the same in both areas.	Dorsal-complex stepped fracturing. Surface looks slightly abraded. Some weak to medium polish development; polish is similar to plant polish but is slightly less bright. Ventral-complex stepped fracturing; less than found on dorsal. Weak polish.
	544	Chouteau	Hoe	Chopping	soil, grass roots, misc. rock	Distal end	20	Faint sheen on working edge; difficult to distinguish from gloss of unaltered chert surface. Small to medium terminated scars	Dorsal-bright polish similar to plant polish. Edge crushed leaving white powdery debirs. Complex fracturing. Ventral-bright polish similar to plant polish. Edge crushed leaving white powdery debris. Complex fracturing.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
								along entire working edge. Most are rectangular or trapizoidal, some of the smallest are scalar.	
	216	Jefferson City	Hoe	Chopping	Soil, grass roots, misc. rock	Distal end	20	Right half of distal end dorsal facing-high gloss polish. In part due to character of chert in that area. Right half of distal edge is very fine grained. Left half of distal edge is much coarser and slightly rough to the touch. There is no visible polish on the left half. Scarring concentrated on the right half of the distal end dorsal facing. Various shapes including triangular, scalar, rectangular and amorphous. Most are stepped. Ventral surface showed no definite use related scars.	Dorsal-bright polish similar to plant polish on surface; no polish or striations on edge. Complex fracturing. Minor crushing with some white powdery debris. Ventral-weak polish development on surface. Complex fracturing on edge. Scars smaller and fewer than those on dorsal; no striations.
Splitting cane for hafting elements	531	Chouteau	Wedge	Pounding stone and wood percussors	Cane	Distal end	10	Battered with complex scarring and white areas at both distal and proximal ends.	Edge-heavily crushed with large amounts of white powdery debris. Complex fractures. No polish; no striations.
Graving antler	835	Burlington	Graver	Graving	Antler*	Pointed tip of distal end	21	After 1 minute extreme tip shattered. After 5 min. tip snapped leaving flat area and a large rectangular scar. Breakage left	Tip-crushed uneven topography. Polish present but impossible to to describe because resolution is poor.

*Dried antler soaked in water for 2 or 3 days.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
								an efficient chisel-like edge. At end of 21 min. tip crushed, smoothed and flattened.	
	557	Chouteau	Graver	Graving	Antler*	Pointed tip of left distal corner	20	1 large scalar scar broke out of tip after 14 min. of working time. Continued work yielded easily observable crushing and smoothing.	Tip-heavily crushed and broken. White powdery debris; no polish no striations.
	222	Jefferson City	Graver	Graving	Antler*	Pointed tip of right distal corner	15	After 4 strokes the tip shattered; after 8 min. a large rectangular scar was removed from the ventral face of the tip. After 10 min. a snap scar was removed just above the tip. At end of working time tip greatly reduced, smoothed and rounded.	Tip-crushed, rough topography; bright polish on projections.
	707	Burlington	Biface	Sawing	Antler*	Left lateral edge	10	At end of work projections resulting from retouch scars had been smoothed and worn until the working edge had an undulate rather than jagged appearance. 1 large scalar scar detached from the interior of a pre-existing rectangular scar after 10 min. of use.	Edge-heavily crushed with white powdery debris. Striation like grooves along edge; no polish. Edge has a generally rough appearance. Some crushing on the dorsal surface.
	502	Chouteau	Biface	Sawing	Antler*	Proximal and medial thirds of left lateral edge	15	Edge abrasion and small to medium scarring. Scars not definitely use	Edge-heavily crushed with white powdery debris. Striations along edge. Some striations filled with white powdery debris.

*Dried antler soaked in water for 2 or 3 days.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
								related although their pattern is consistent with that defined for sawing. A slight sheen was observed on area of the tool surface where the operator's fingers had rested.	
	291	Jefferson City	Biface	Sawing	Antler*	Proximal and medial thirds of right lateral edge	11	Original projections formed by retouch scars had been substantially smoothed or worn away. At the end of the working time the tool was dull and no longer workable for this function.	Edge-heavily crushed with accompanying white powdery debris. Rough broken topography with no identifiable scar form. No striations; no polish.
Planing antler	722	Burlington	Scraper	Transverse cutting	Antler*	Distal third of left lateral edge	20	Dorsal-complex scarring not definitely a product of use. Ventral-slight trough or depression worn into surface. Interior appears smoother and finer grained than surrounding unmodified chert. No sheen or luster was visible.	Dorsal-area within 1 mm of edge rounded with bright polish. Polish similar in brightness and texture to plant polishes. Ventral-edge crushed but not fractured. Linear areas of polish are roughly perpendicular to the edge. No striations.
	541	Chouteau	Scraper	Transverse cutting	Antler*	Central portion of distal end	20	No definite use related damage. Unused tool was heavily battered by production. Edge felt blunted although no rounding was visible.	Dorsal-complex scarring. Crushing with white powdery debris. Some poorly developed polish. Ventral- minor crushing with white powdery debris. 1 large and 1 small scalar scar. Weak, ill defined polish in sleek like formations. They lie roughly perpendicular to the edge.
	139	Jefferson City	Scraper	Transverse cutting	Antler*	Left half of distal end	20	No definite use related scarring 1 area of barely preceivable smoothing on ventral surface. Edge felt blunted although no rounding was visible.	Dorsal-crushing with white powdery debris within 1 mm of edge. Patches of ill defined polish in same area. Ventral-major crushing accompanied by white powdery debris. A ridge of the debris lines the entire working edge. Portions of the ridge brushed away easily with a needle.

*Dried antler soaked in water for 2 or 3 days.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
Hollowing a log	823	Burlington	Adze	Chopping	Hard wood	Distal end	14	Large complex fractures on both faces. Some examples large enough to be classified as retouch. A gloss indicating possible polish development observed on dorsal surface. Work halted when hafting element broke.	Dorsal-complex fracturing. Crushing accompanied by white powdery debris. No polish visible; resolution poor. Ventral-edge crushed but with little white powdery debris. 1 area of bright polish development.
	542	Chouteau	Adze	Chopping	Hard wood	Distal end	20	Major step fracturing of the same shape and size as the original retouch. Gloss on dorsal surface suggests possible polish.	Dorsal-heavily crushed leaving white powdery debris. Massive complex fracturing. Very weak isolated polish. Ventral-massive complex scarring. Weak but pervasive polish development.
	220	Jefferson City	Adze	Chopping	Hard wood	Distal end	20	Complex fracturing less in size and extent than that suffered by 823 and 542.	Dorsal-heavy crushing accompanied by white powdery debris. Minor polish development. Complex fracturing. Ventral-crushing with white powdery debris. Weak polish development. Complex fracturing.
Graving wood	838	Burlington	Graver	Graving	Seasoned oak	Pointed tip of distal end	23	Tip shattered during first stroke. Point remained sharp enough for continued use.	Tip-rough broken topography. 1 area of well developed polish. Polish covers all projections and depressions. It is almost as bright as plant polish.
	560	Chouteau	Graver	Graving	Seasoned oak	Pointed tip on proximal third of left lateral edge	25 all three areas combined	Tip-no definitely use related scarring; some rounding and smoothing.	Tip-major crushing with white powdery debris; no polish.
						Medial third left lateral edge		2 large scalar scars on dorsal face.	Heavily crushed with white powdery debris; no polish.
						Distal third of right lateral edge		1 large snap scar with hinged termination.	Heavily crushed with white powdery debris. Some smoothing and polish development; polish development appears directional but resolution is poor.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	224	Jefferson City	Graver	Graving	Seasoned oak	Pointed tip on left distal corner	15	Tip shattered on first stroke. Stabilized enough for continued use.	Tip-crushing accompanied by white powdery debris. 1 area of very slight, very poor polish development.
Sawing wood	820	Burlington	Denticulate	Sawing	Seasoned oak	Teeth 4 through 6 counting from proximal end	4	1 large rectangular flake detached from ventral face. Tool too dull for continued use at end of working time. There was, however, no other definitely use related scarring.	Edge-complex fracturing. Crushing accompanied by white powdery debris. No polish, no striations; no distributional pattern of scars like that defined for sawing.
	525	Chouteau	Denticulate	Cutting sawing	seasoned oak	Teeth 2 through 4 counting from proximal end	9	1 tooth broke off; other teeth, originally square, were worn to short stubby triangles. No definitely use related scarring.	Edge-tips of teeth crushed with white powdery debris. Complex fracturing. Minimal poorly developed polish. No striations, no sawing scarring pattern.
	204	Jefferson City	Denticulate	Sawing	Seasoned oak	Teeth 4 through 7 counting from proximal end	6	1 large amorphously shaped flake removed from dorsal face of central tooth. Large complex scarring and general attrition c[illegible] edge. Tool too dull for continued use after 6 minutes.	Edge-complex fracturing, crushing with white powdery debris. No polish; no sawing scarring pattern.
	809	Burlington	Biface	Sawing	Seasoned oak	Proximal half of left lateral edge	5.5	Post use, complex scarring observed along both faces but particularly on the dorsal face. During use, some removals of flakes of a particular shape and size were noted. However, as they accumulated, they were no longer distinguishable.	Edge-minimal to medium crushing with white powdery debris. Snap and stepped complex fracturing; no polish, no striations.
	401	Chouteau	Biface	Sawing	Seasoned oak	Proximal third of left lateral edge	20	No definitely use related scarring was observed. Tool became dull and inefficient by the end of the working period.	Edge-heavily crushed with accompanying white powdery debris. Some small snap and complex fractures. No polish, no striations.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	539	Chouteau	Biface	Sawing	Seasoned oak	Proximal half of left lateral edge	2	Edge attrition was massive and swift. Edge heavily damaged and dull at end of 2 minutes. 2 large snap scars were observed.	Edge-heavily abraded and crushed with accompanying white powdery debris. no polish, no striations.
	113	Jefferson City	Biface	Sawing	Seasoned oak	Medial third of left lateral edge	10	The original step-fractured edge was smoothed with some pre-existing scars obliterated. Replaced by back-to-back scalar scar and later by rectangular ones.	Edge-heavily crushed with white powdery debris. Snap and complex fractures. No polish, no striations.
Whittling wood	730	Burlington	Spokeshave	Transverse cutting	Seasoned oak	Concavity in medial third of right lateral edge	20	General attrition of edge. 1 area of large complex scarring in center of concavity.	Dorsal-crushing with white powdery debris. Complex fracturing. No polish, no striations. Ventral-crushing with white powdery debris. Complex fracturing. No polish, no striations.
	572	Chouteau	Spokeshave	Transverse cutting	Seasoned oak	Concavity in distal end	20	4 small scalar scars in concavity.	Dorsal-complex stepped fracturing along edge. No polish, no striations. Ventral-same.
	141	Jefferson City	Spokeshave	Transverse cutting	Seasoned oak	Concavity in left half of distal end	20	Shallow bell-shaped depression on ventral face. Tool seemed blunt although there were no definitely use related scars and no visible rounding.	Dorsal-heavily crushed with accompanying white powdery debris. No polish, no striations; complex scarring. Ventral-rounding of edge. Crushing with white powdery debris. Rectangular and complex scarring. Minimal, weak polish development.
	732	Burlington	Flake	Transverse cutting	Seasoned oak	Medial third of right lateral edge	20	Edge-general blunting and attrition. Dorsal-shallow groove worn into face. Interior of groove showed dull luster. Several tiny scalar and rectangular flakes removed from edge. Ventral-large scalar scars.	Dorsal-edge crushed. Little white powdery debris remain. Sparse poorly developed polish on projecting portions of rough surface. Ventral-large scalar and snap scars. Some crushing, no polish.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	567	Chouteau	Flake	Transverse cutting	Seasoned oak	Proximal half of right lateral edge	12	After 7 minutes of use 2 large elongated scalar scars and 1 trapizoidal scar observed on ventral face. After 12 minutes of use, tool was dull and working edge was becoming concave. The 3 large scars had been obliterated by virtually continuous small scalar scars. A mitten-shaped groove had also formed on the dorsal face.	Dorsal-complex scarring; crushing with accompanying white powdery debris in groove and along edge. Complex and rectangular stepped scars; weak poorly developed polish. Ventral-complex and rectangular stepped scars. Crushing with accompanying white powdery debris; no polish.
	240	Jefferson City	Flake with slight retouch	Transverse cutting	Seasoned oak	Distal third of left lateral edge	20	After 4 minutes of use a long thin rectangular chip detached from the dorsal face. At the end of the working time, a cluster of 3 rectangular scars on the ventral face and more dispersed scalar scars on the dorsal were observed.	Dorsal-area slightly retouched. Complex scarring; crushing with white powdery debris. No polish, no striations. Ventral-heavy crushing on edge and surface accompanied by white powdery debris; striations.
	242	Jefferson City	Flake	Transverse cutting	Seasoned oak	Distal third of left lateral edge	20	After 2 minutes of use 1 large trapizoidal and 1 medium scalar scars were observed on the dorsal face. After 12 minutes use the tool was noticeably dull. However there was no obvious damage other than a shallow rectangular groove on the ventral surface. 1 small area of polish was observed on the extreme edge. It would probably have escaped notice if I had not known that the area had been utilized.	Dorsal-heavily crushed with accompanying white powdery debris. Scalar scars; interiors of the scars also crushed. No polish, no striations. Ventral-heavily crushed with accompanying white powdery debris on edge and surface. Complex scarring. No polish, 1 faint striation.
Planing bark and wood	721	Burlington	Scraper	Transverse cutting	Seasoned oak and soft wood	Distal end	20	Complex scarring; edge fractured easily.	End: Dorsal-heavily crushed with accompanying white powdery debris. No polish, no striations. Ventral-minor crushing, striations slight, poorly developed polish.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
						Distal third of right lateral edge			Side: Dorsal-heavily crushed with white powdery debris. Complex scarring. No polish, no striations. Ventral-crushing with white powdery debris on edge and surface. No polish, weak striation-like features.
	409	Chouteau	Scraper	Transverse cutting	Seasoned oak	Distal end	25	Dorsal-smoothing of original battered surface; some original stepped scars obliterated. 2 amorphously shaped scars appear to have resulted from use. Ventral-a shallow trough perpendicular to edge, a single trapezoidal scar formed in the trough.	Dorsal-heavily crushed with accompanying white powdery debris. Complex fracturing, no polish, no striations. Ventral-slight crushing. Scalar and large rectangular scars. No polish, no striations.
	293	Jefferson City	Scraper	Transverse cutting	Seasoned oak	Distal end	21	Dulled quickly although no definitely use related damage was observed.	Dorsal-heavily crushed with accompanying white powdery debris. Complex fracturing. Small amounts of polish at extreme edge. Ventral-crushing with white powdery debris. Complex scarring. Minimal weak polish, no striations.
Drilling holes in wood with unhafted drills	828	Burlington	Drill	Boring, one way turn 360°	Seasoned oak	Tip at proximal end	20	Slight smoothing of tip no definitely use related scarring.	Tip-crushing with accompanying white powdery debris. Rough, pebbly topography. 1 roughly oval area of bright polish. Dorsal near tip-Rough topography, crushing with white powdery debris at margins. Polish on projections, no striations.
	546	Chouteau	Drill	Boring, one way turn 360°	Seasoned oak	Tip at proximal end	20	Tip audibly fractured at beginning of procedure. No particular scar form identifiable.	Tip-crushed with accompanying white powdery debris. 1 thin line of bright polish on extreme tip. Ventral near tip-shallow, roughly parallel striations run parallel to tip; look like sleeks rather than furrows.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	214	Jefferson City	Drill	Boring, one way turn 360°	Seasoned oak	Tip at proximal end	20	Tip slightly smoothed at extreme end. No definitely use related fracturing observed.	Tip-rough fractured topography. Crushing with accompanying white powdery debris; no polish. Dorsal ridge near tip-rough topography minimal polish development.
Drilling holes in wood with hafted drills	827	Burlington	Drill	Boring, reverse turn 180°	Seasoned oak	Tip at proximal end	20	Tip slightly smoothed at extreme end. No use related fracturing observed.	Tip-crushed with accompanying white powdery debris. 1 long oval area of bright polish on extreme tip. Dorsal spine near tip-some smoothing. Bright polish on the projection; no striations.
	548	Chouteau	Drill	Boring, reverse turn 180°	Seasoned oak	Tip at proximal end	20	After 11 minutes use tip was smooth and glossy. A bean-shaped flake detached. At the end of 20 minutes use the tip was even more smooth and glossy and the margins of the scar had been abraded.	Tip-rough broken topography. No white powdery debris. Some smoothing of projections. Bright well developed polish. Dorsal near tip-crushing with accompanying white powdery debris on face and margins. Complex scarring, slight, poorly developed polish, no striations.
	213	Jefferson City	Drill	Boring, reverse turn 180°	Seasoned oak	Tip at proximal end	20	Tip slightly smooth to the touch. No use related scarring damage observed.	Tip-complex fracturing, crushing with white powdery debris. Some poorly developed polish. Ventral near tip-crushed with accompanying white powdery debris on surface and edge. Complex fracturing on edge; no striations.
Graving shell	836	Burlington	Graver	Graving	Fresh water clam shell	Pointed tip on left corner of distal end	25	Tip fractured during first stroke. During second stroke a long narrow rectangular scar formed along the edge of the point. After six min. of use a large triangular flake detached from the tip yielding a sharper point. At the end of the working period the tip was substantially reduced, smoothed and rounded.	Tip-rough fractured topography. Some crushing with accompanying white powdery debris. No polish, no striations.

TABLE 4: Continued

First Experimental Series: Description and Results

Function	Tool Number	Chert Type	Shape Class	Action	Material	Area Utilized	Use Time/ Minutes	Macroscopic Damage	Microscopic Damage
	561	Chouteau	Graver	Graving	Fresh water clam shell	Pointed tip on right corner of distal end	25	After 10 min. use a medium scalar scar formed on the tip. At the end of the working period the tip was reduced, smoothed and flattened. The margins of the scar had been smoothed. a fresh, unsmoothed scalar scar was also observed.	Tip-heavily fractured and crushed with accompanying white powdery debris. Complex stepped fractures. No polish, no striations.
	225	Jefferson City	Graver	Graving	Fresh water clam shell	Pointed tip on distal end	25	After 8 min. use a large triangular scar formed on the tip. At the end of the working period the tip had suffered obvious attrition. It was smoothed, rounded and flattened. The margins of the scar had been abraded.	Tip-rough broken topography. Bright polish in depressions and on projections. Polish resembles that associated with both wood and antler.
Grinding edges of drills in preparation for hafting	1001	Sandstone	Abrader	Grinding	Chert	Center of stone and edge of stone (see grooved areas)	17.5	3 triangular shaped troughs 2, 4.7, and 1.3 mm deep respectively.	Interior of trough-no polish, no striations. Appears that sand particles detached from matrix.

used only for pointed tools such as gravers and perforators. Plate 1a shows an example of this use-wear type.

In addition to the scar types defined in the model, other forms were noted in the first experimental series. They are complex, elongated, amorphous, bean-shaped, and retouch-like scars.

Complex scars are concentrated over-lapping scar formations where the shape and the distinctness of individual scars have been lost. Plate 2a and Figure 8 (following) show examples of this scar form. This scar type occurs most frequently on retouched tools where the retouch scars and scars which are artifacts of production interlace with subsequent use-wear scars to the point that they cannot be distinguished. The complex form can also occur on unretouched tools depending upon the use-wear damage formations on those tools or on the interplay of production scarring and/or lances.

Elongated scars are generally rectangular or sub-rectangular in shape. They are very thin in relation to their length and always lie with one of the narrow margins on the working edge (Figures 7a, 8b).

Amorphous scars are non-complex scars having no identifiable geometric shape; they are generally ameboid (Figs. 7b', 10b).

Bean-shaped scars are, as their name implies, shaped like kidney beans. This is a rare form; only one was noted in both the experimental series presented in this paper.

Retouch-like scars are massive use-wear scars which are similar in size and shape to the intentional retouch found on the same tool. This use-wear form is identifiable only in experimental situations such as this where the tools were observed and recorded in detail both before and after use. This form would be indistinguishable from later intentional retouch in an archeological collection.

Lances are generally macroscopic features which resemble striations both in appearance and in orientation. They are an artifact of production, not a form of use-wear. As noted in a preceding section, they are the result of the expansion and partial contraction of the raw material due to the force applied when removing flakes from a core or a retouched edge. They are most often found on flakes or unretouched tools but can also be observed in retouch scars on modified tools. Plate 1c shows lances observed on an unutilized tool. Plate 1d shows the same lance after tool use. The narrow area of striation-like polish within the lance is the product of use. Plate 1f shows true striations.

Attrition is a use-wear form in which the stone is substantially abraded but with little or no remaining scarring damage. Figures 11a - 11f illustrate this use wear type. Note both the before and after outlines of the tools.

Dulling is a related kind of abrasive wear. The abrasion is, however, much less well developed. At the macroscopic level, dulling cannot be seen; it can, however, be discerned with the finger tips and in the inaction of the tool. At the microscopic level, it can be seen as a very slight reduction of a previously acute edge. Blunting is used as a synonym for dulling in Table 4.

Smoothing and rounding are mid-range abraded use-wear forms which tend to occur together. Smoothing can occur both on the surface and/or the edge of the tools. It is the reduction of the unaltered grainy surface to an even plane. It does not have a glossy or shiny appearance either macro- or microscopically. Rounding occurs only on the working edge. Its physical properties are the same as those for smoothing with the addition of a visible curve to the originally acute edge.

Crushing and crushing with debris are also abrasive forms of use-wear. They are similar in extent to smoothing and rounding but result in an uneven mashed rather than smooth topography. The debris associated with crushing resembles a white powder which clings to the crushed surface. It can easily be removed with the point of a pin. It is, however, surprisingly tenacious. It was observed on some tools which had been washed. Although no chemical analysis of the debris was performed, it appears to be fine crumbs of chert. Its appearance is the same for all chert types, and it was observed in the same form on separate tools used to process each of the materials included in these experiments. Plate 2b shows crushing with debris and Plate 2c shows crushing without debris.

The phrase "no definitely use related damage" is not actually a use-wear form. It is included here because it refers to macro-scopic situations where some scarring can be observed but where the source of that scarring, e.g., production, incidental damage, use-wear or combinations of these, cannot be determined. The category arose as a result of the detailed observations of pre-existing damage made on each tool prior to use. It is needed most often, but not exclusively, when describing retouched tools.

Discussion of Use-Wear Damage Indicative of Mode of Action

THE MODEL VS. THE DISTRIBUTION OF CUTTING DAMAGE OBSERVED

The model presented in Table 1 states that the action of cutting can be recognized by discontinuous groupings of scars alternating from fact to face of the tool. In the first experimental series, 20 separate tools were used only for the action of cutting; 10 of these were flakes and 10 were bifaces. Of these 20, only six or 30% had wear patterns consistent with the model. All six of these were flakes.

Of the six flakes displaying the ideal pattern, only three were identifiable at the macroscopic level of observation. See Figures 4b and 4b' for an example of this configuration. The remaining three consistent patterns were identifiable using a magnification of 105X.

Of the four flakes which deviated from the model, one displayed an indeterminant pattern of scalar and complex scars which is closer to sawing than cutting. See Figures 5b and 5b' for an example of this pattern on a cutting tool. Two of the flakes had snap scars along the entire length of the working edge. Because snap scars involve both faces simultaneously, no alternating pattern is possible with this type scar. The fourth flake displays no scarring pattern but does have striations running at a 40° to 45° angle from the edge on the ventral face. While the angle of the striations is consistent with one form of cutting as described in the model, the appearance of the striations only on the ventral face is inconsistent with the cutting action actually performed. Instead, this configuration is indicative of transverse cutting where only one face of the tool is in contact with the material being worked.

The ten bifaces used for cutting actions deviate more widely from the ideal. All of the scarring patterns were complex and did not follow any distributional pattern presented in the model. These and the other bifacial tools used in the first experimental series will be discussed in more detail in a later section.

The classic cutting distribution of use-wear scars should be treated with caution. Figures 6a through 6c illustrate this pattern found on an unutilized flake. This will be discussed more fully in the section on incidental damage.

THE MODEL VS. THE DISTRIBUTION OF SAWING DAMAGE OBSERVED

The model presented in Table 1 states that the action of sawing can be recognized by a scarring distribution similar to cutting. As with cutting, the scars are on both

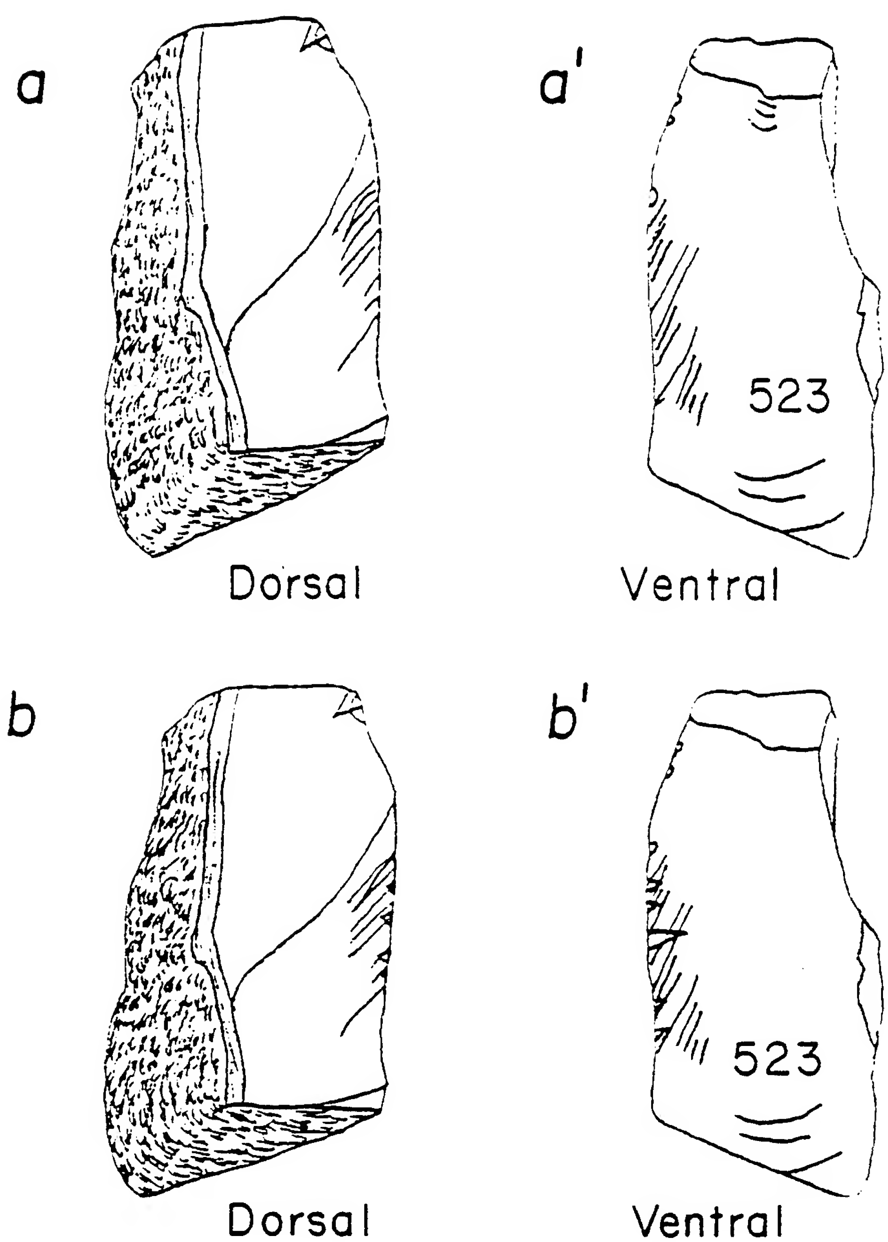

Figure 4. Record of macrowear damage on a flake used to disarticulate a joint using a cutting motion - a, a' before use; b, b' after use. Diagonal lines are lances, not striations.

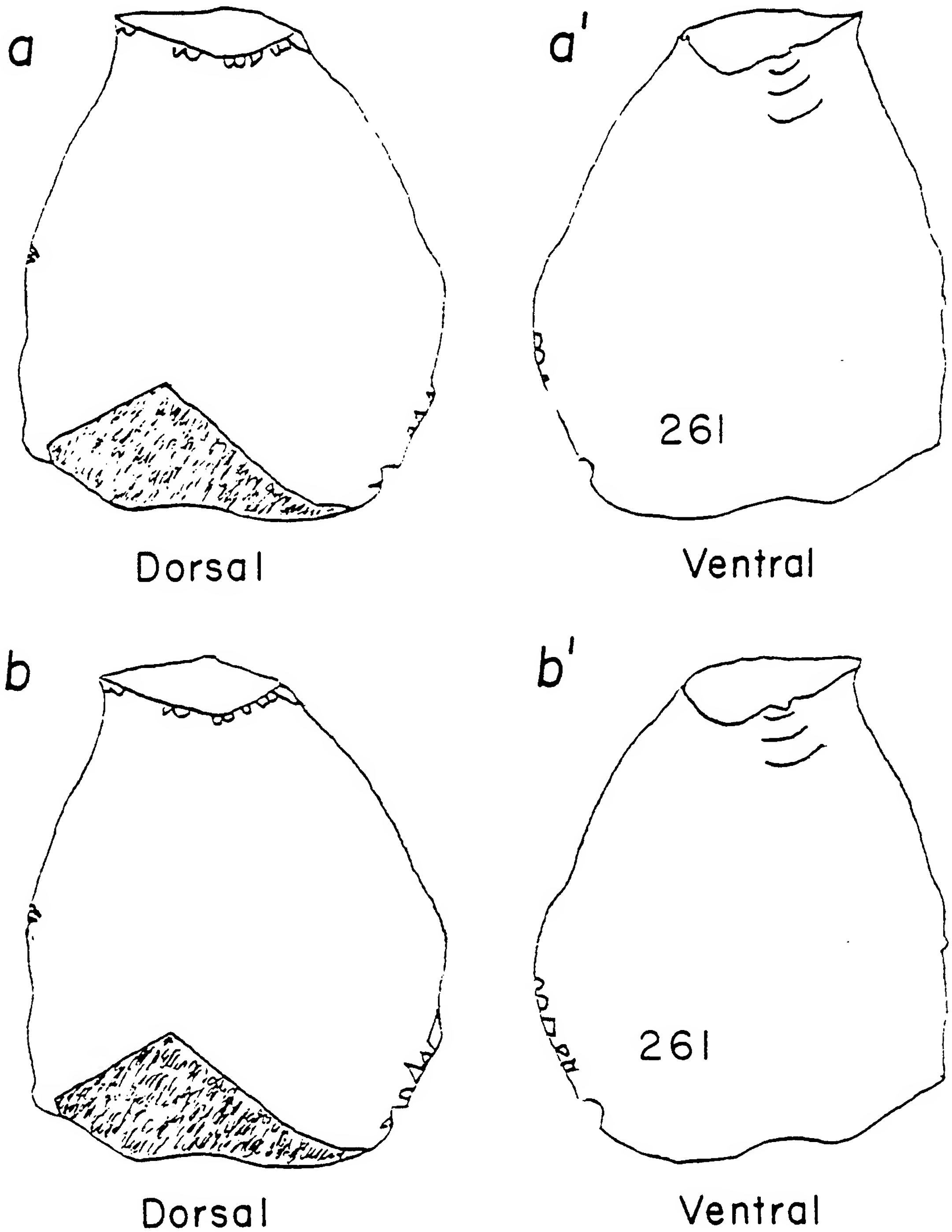

Figure 5. Record of macrowear damage on a flake used to skin a deer. Only a cutting motion was used - a, a' before use; b, b' after use.

faces of the edge and extend for the entire length of the working edge. Unlike cutting, the sawing pattern shows a greater density of scars and a tendency for them to be found opposite each other on the respective edges. Striations associated with sawing are uniform on both faces and lie parallel to the working edge. Rough antler polish as opposed to smooth antler polish is also associated with sawing that material.

A total of 15 tools were used for sawing actions in the first series of experiments. Only one of the 15 or 7% exhibited a scarring pattern consistent with the model. This consistency lies only in the distribution of the scars. The tool showed no striations and was not used to process antler.

The lack of consistency found in this set is mitigated to some extent by the fact that all fifteen tools are extensively, bifacially retouched. The model was generated for flakes. Figures 7a - 7b' illustrate this damage.

Retouched tools used for sawing, like those used for cutting, display markedly different damage patterns from flake tools. At the macroscopic level the primary form of wear for retouched tools used as saws is the general reduction of the edge through attrition rather than scar formation. Only seven tools showed any definitely use related scarring. In three instances, this scarring was restricted to single scars. In the other instances, scarring was complex with one tool showing complex scarring which was virtually indistinguishable from intentional retouch and related manufacturing damage. This level of damage would not have been identifiable as use-wear if it occurred on an archeological tool.

At the microscopic level the dominant use-wear form on all fifteen sawing tools was crushing with accompanying white powdery debris. One tool showed a single striation running along the apex of the edge. There were no striations on either the dorsal or ventral faces.

MODEL VS. TRANSVERSE CUTTING USE-WEAR DAMAGE OBSERVED

The model presented in Table 1 indicates that the action of transverse cutting may be recognized at the macroscopic level by a concentration of scars within a small area. These scars occur only on the face of the tool opposite that in actual contact with the material being worked. The scars are regular in size and shape. At the microscopic level, striations occur only on the face of the tool in contact with the worked material. The striations are oriented either perpendicularly to or diagonally from the working edge, depending

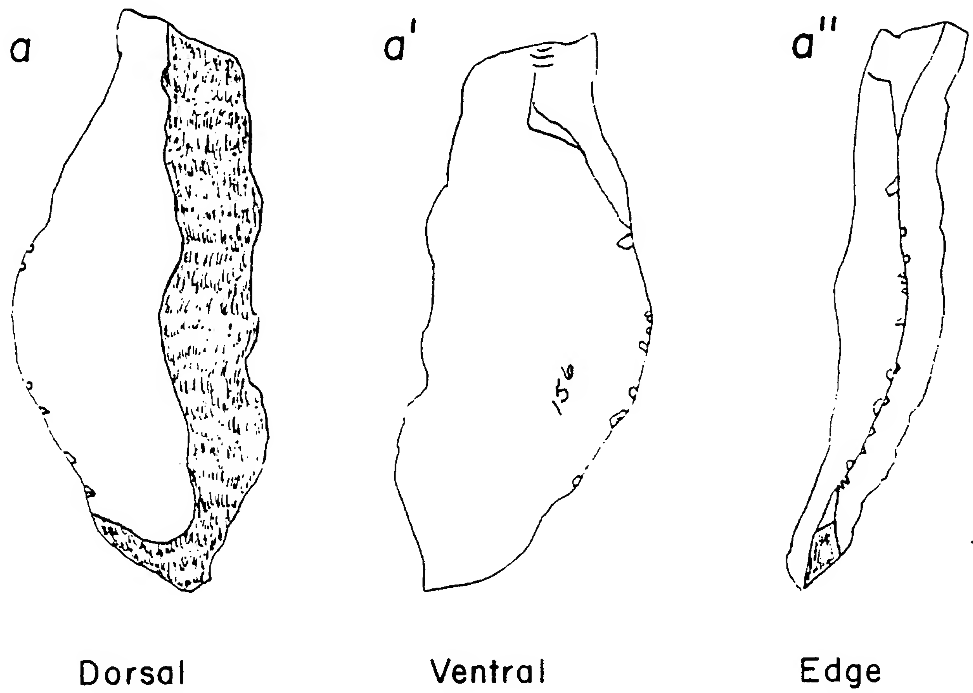

Figure 6. Record of manufacturing related macrowear damage on an unused flake. The size and distribution of the scars are like those associated by Tringham et al. (1974) with cutting soft materials.

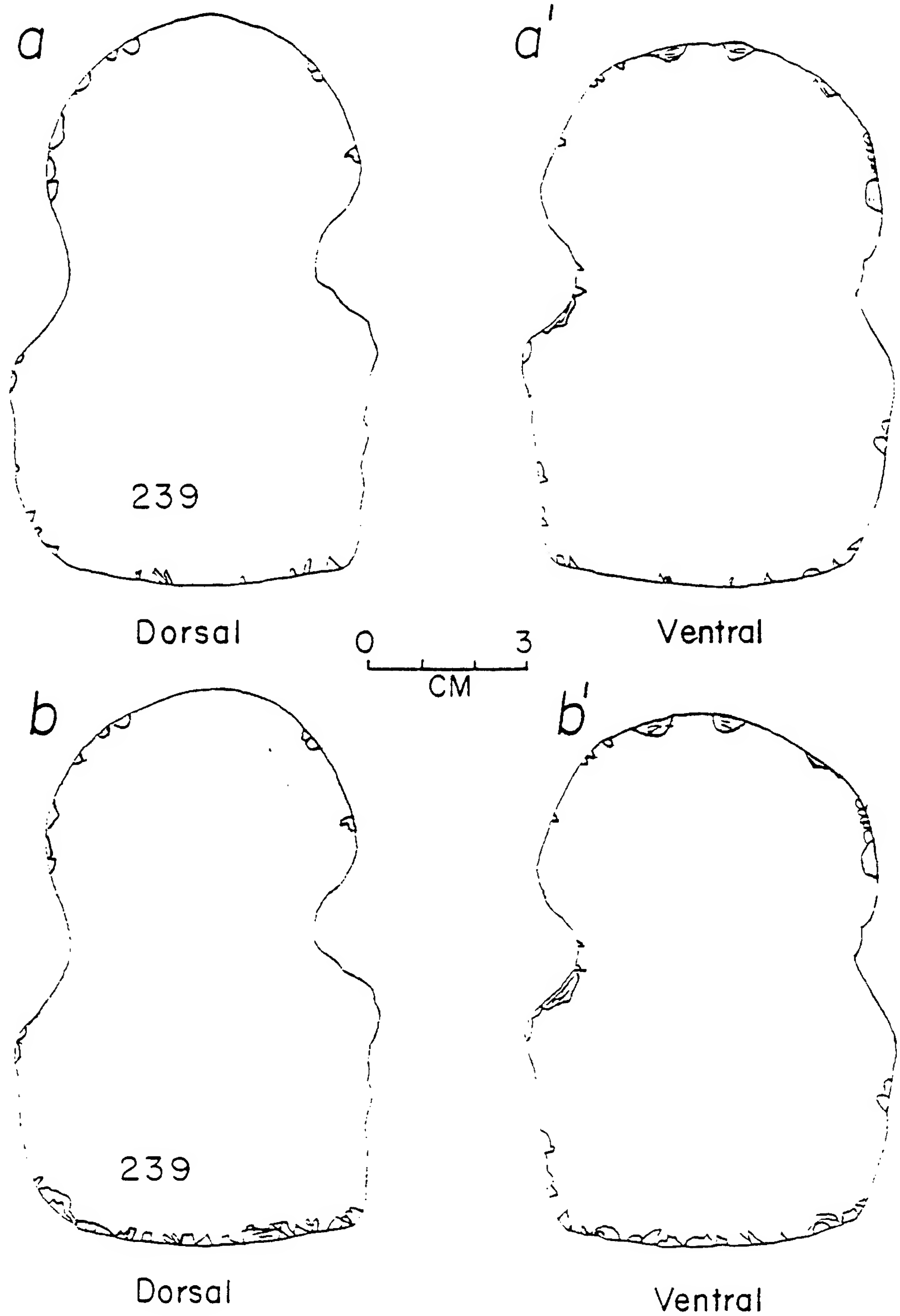

Figure 7. Record of macrowear damage on an axe used to disarticulate two joints using cutting and chopping motions - a, a' before use; b, b' after use.

on the direction of applied force. Additionally, a distinctive smooth antler polish is associated with transverse cutting actions performed on that material.

In the first experimental series a total of 23 tools were used for transverse cutting actions on both hard and soft materials. Of these tools, one tool had no notation regarding the face in contact with the material worked and is, therefore, not included in the assessment of the degree of correspondence between the model and the results observed in the first experiment. Of the remaining 22 tools used for transverse cutting only one or 4% showed use-wear consistent with the model. Six of those showing use-wear inconsistent with the model had no definitely use related damage. All of these tools were used to process fresh hide.

Of the others, five had no scarring on the contact surface but did have attrition damage expressed primarily as trough-like depressions of various shapes. While this damage is not discussed in the model, it can be considered indicative of sustained localized force with the same tool area in contact with the material being worked. This kind of wear was not observed with any other action performed in this experimental series. While this use-wear formation appears to be diagnostic, there are some limits on its occurrence. In this series it was observed only in instances where the material worked was hard; it did not, however, occur in all instances of working hard materials. The troughs occurred only on flakes or on the unretouched portions of unifacial tools where the unretouched surface was in contact with the hard material. In this series, troughs did not form in retouched areas. It is possible but not proven that with substantially longer working times, assuming that the cutting ability of the edge could be sustained long enough, troughs might develop in retouched surfaces.

In the remaining nine instances, scarring damage was observed not only on the surface opposite the contact surface, but also on the contact surface itself. This is a direct contradiction of the model and is the most frequent use-wear pattern observed in this experimental series. It must therefore be considered the expected form for this action with these tools. Figures 8, 9, and 10 illustrate this inconsistency. Tool 533 (Fig. 8) was used to plane bone. Its ventral face was the contact face. Tool 722 (Fig. 9) was used to plane antler. Its ventral surface was in contact with the material. Tool 530 (Fig. 10) was used to scrape fresh hide. All three tools have use-wear scars on their contact surfaces.

For the one remaining tool, two scars were observed on the contact surface. It cannot, however, be considered an

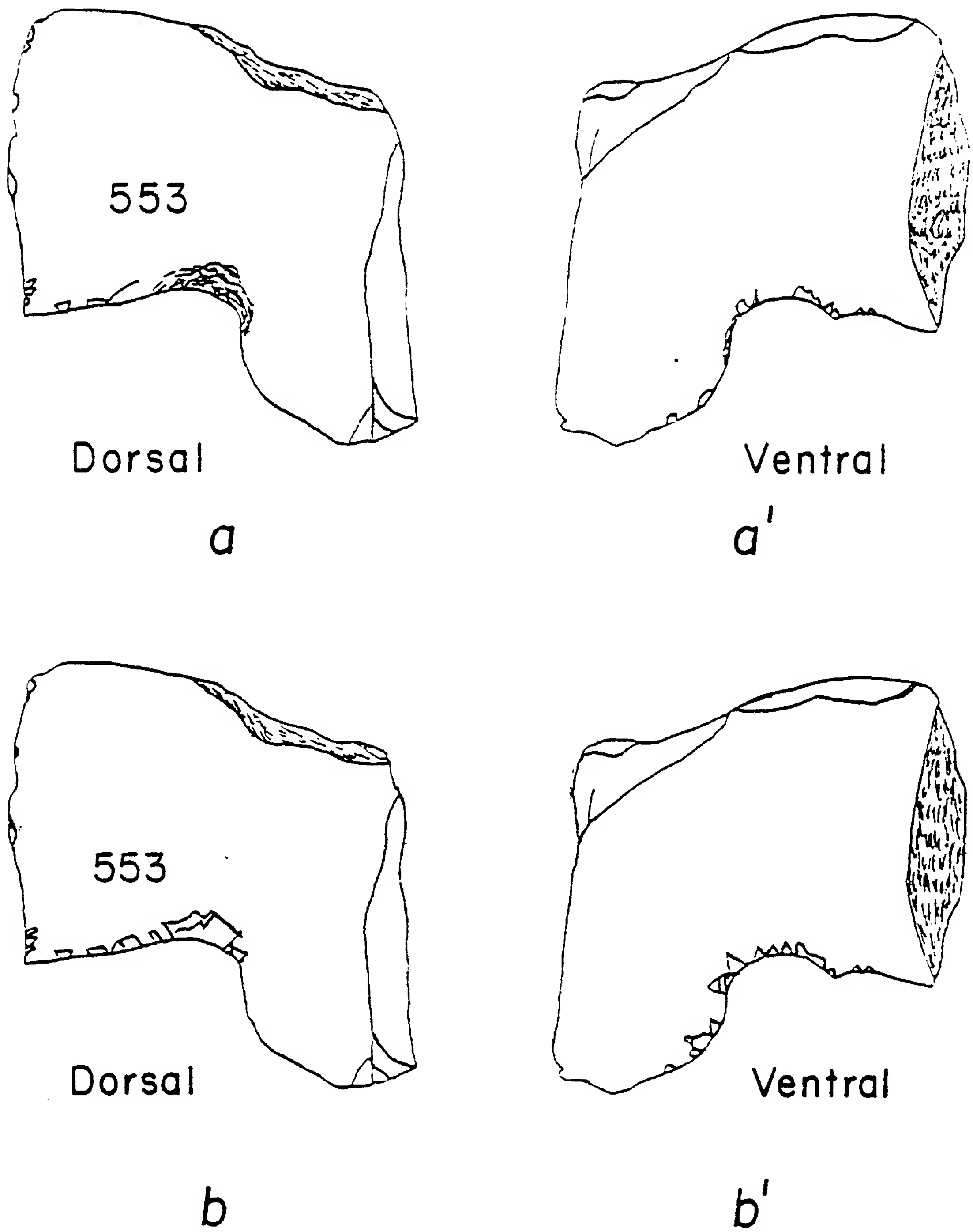

Figure 8. Record of macrowear damage on a spokeshave used to whittle bone - a, a' before use; b, b' after use.

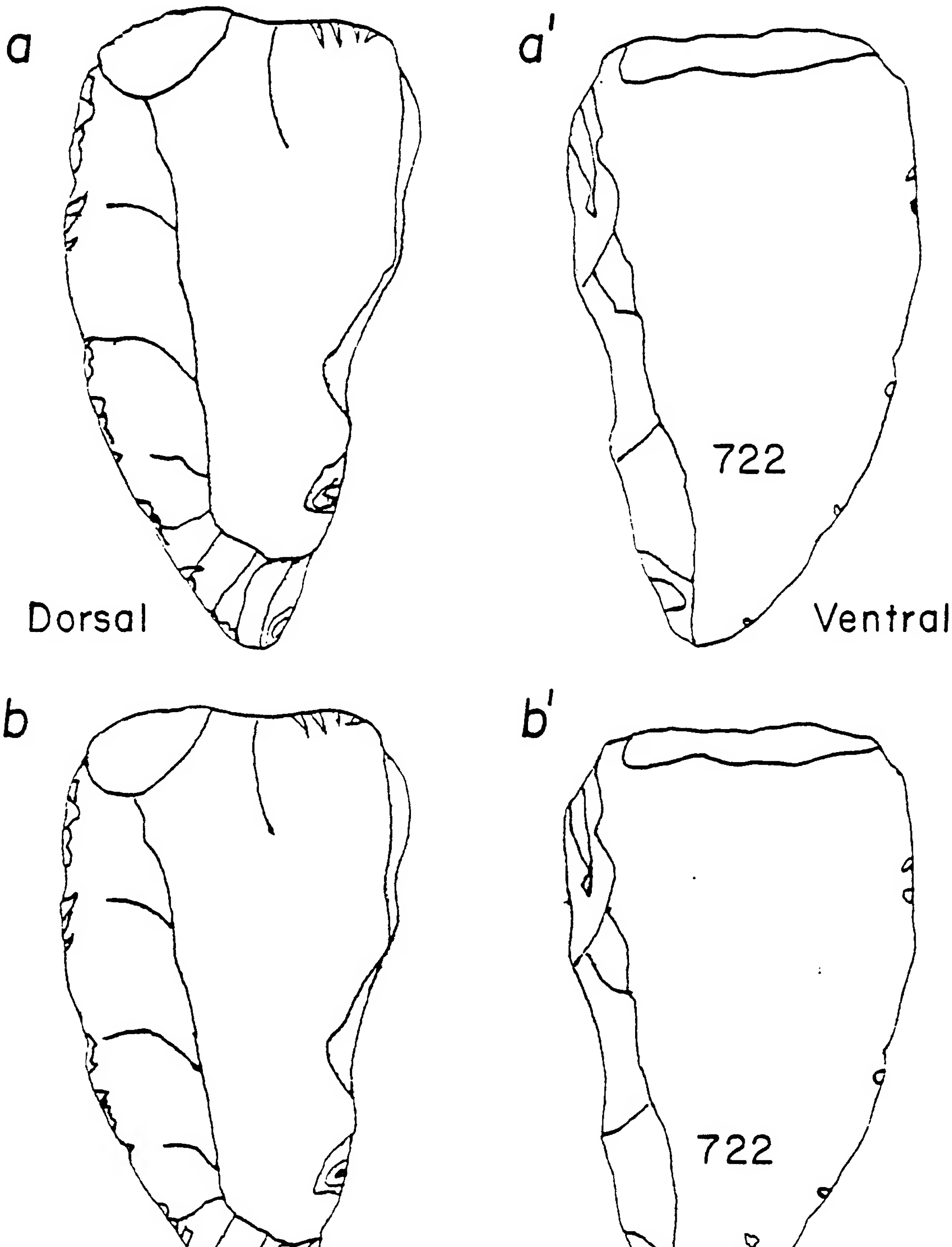

Figure 9. Record of macrowear damage on a spokeshave used to plane antler - a, a' before use; b, b' after use.

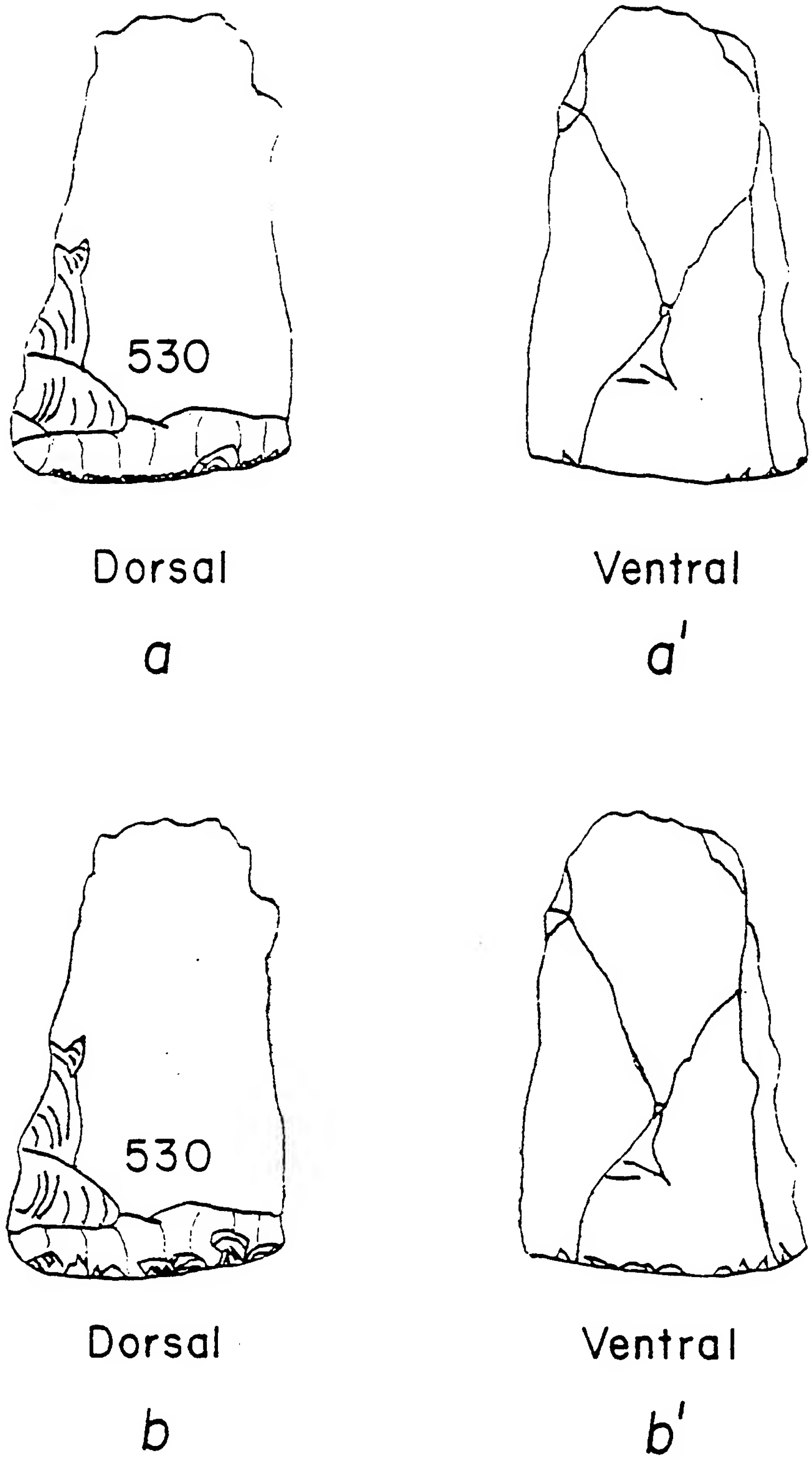

Figure 10. Record of macrowear damage on a scraper used to scrape fresh hide - a, a' before use; b, b' after use.

inconsistency because the source of the damage was a carpet tack used to secure the hide being processed and is more correctly wear foreign to a true aboriginal replication.

At the microscopic level, the observed results of this experimental series are more in line with the model drawn from the literature. Striations or striation-like areas of crushing were observed on seven of the 22 tools used for transverse cutting. In six of these instances or in 3% of the total cases, the striations were observed only on the surface in contact with the material being worked. These striations followed the line of force applied. In one instance, striations were observed on the surface opposite that in contact with the material. No striations were observed on the contact surface.

As in all other actions performed for this series, the dominant microscopic use-wear features for all of the tools were crushing and/or crushing with debris. These forms occurred on all 23 tools and on both faces of each tool.

MODEL VS. GRAVING USE-WEAR DAMAGE OBSERVED

The model presented in Table 1 does not discuss a pattern of macroscopic damage associated with the action of graving. Microscopically, a pattern of striations parallel to the cutting plane but generally at right angles to the axis of the tool are believed to be found on the sides of graver points.

A total of 13 individual tools were used for graving actions in the first experimental series. All of them were thin minimally retouched flakes. None of them were consistent with the model as presented in Table 1.

Microscopically, only one tool showed striations. Unlike the model, these striations ran parallel to each other across the face of the extreme tip of the tool which had been flattened and smoothed by use. Another tool showed polish development like linear features following the line of tool movement. The actual characteristics of this pattern could not be determined because of poor resolution. This pattern was observed on the edge rather than the tip and may not be associated with the action of graving. The tips of all 13 gravers were heavily crushed or broken with white powdery debris. In six instances, there was some smoothing and polish development on the projections of the rough surfaces of the tips.

Macroscopically, there is no particular scar type associated with graving based on this sample. Shatter, snap, rectangular, scalar, and triangular scars were all observed in more than one instance while utilizing these

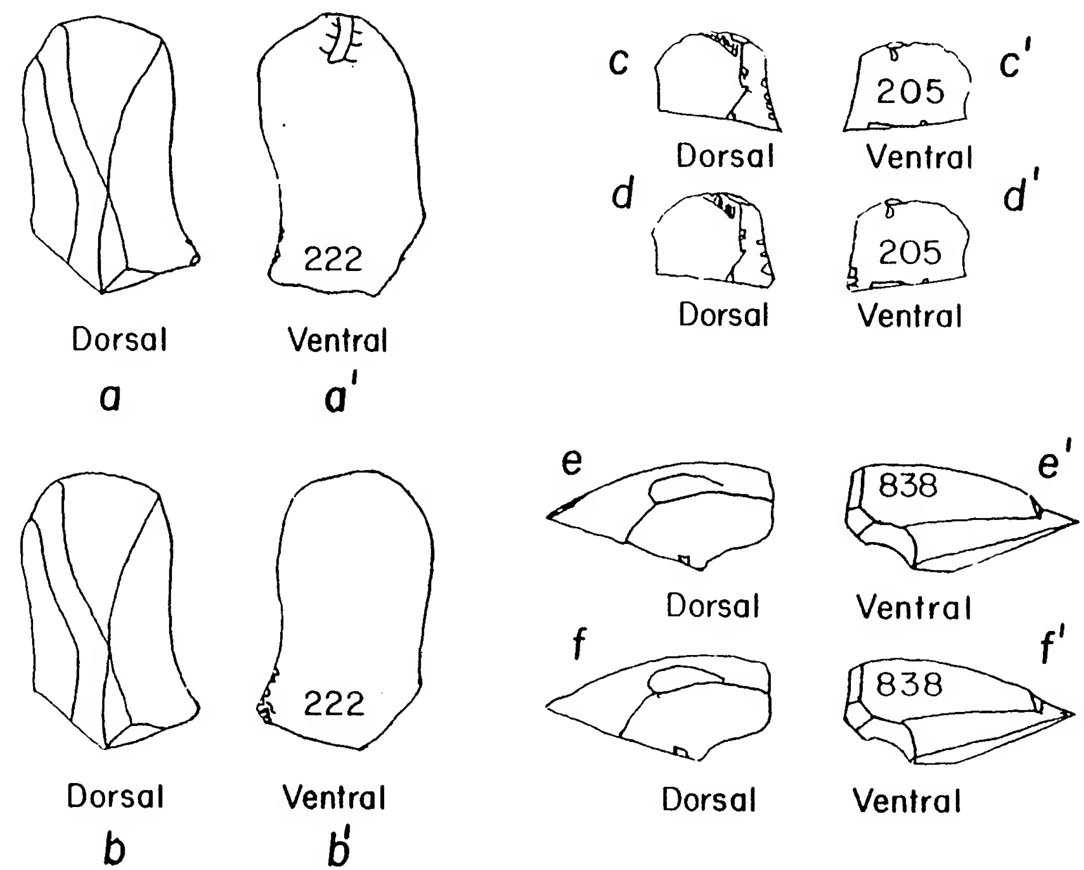

Figure 11. Record of macrowear damage on gravers used to grave antler (#222), bone (#205) and wood (#838) - a, a', c, c', e, e' before use; b, b' after use.

tools. However, in all but two instances continued use produced attrition of the tip and smoothing and rounding of the tip surface. The margins of existing scars were obliterated. In the other two instances, the graver tips shattered near the end of the working period. Based on other examples which had shattered and subsequently became smoothed and rounded, these two could be expected to do the same if work had continued. However, in their shattered state, the damage appeared incidental rather than use related. See Figures 11a - 11f' for examples of these damage forms.

While macroscopic smoothing and rounding and microscopic crushing with white powdery debris are not unique to graving actions, the combination of these wear forms on the pointed tip or projection of a minimally modified flake may be indicative of graving actions with that tool form. This conclusion is based in part on the fact that the examples from the first experimental series are too frail for boring or piercing actions which also produce these patterns of wear. If the gravers were larger and stronger forms which could also be used for boring or piercing, the diagnostic value of these patterns becomes null.

MODEL VS. PIERCING USE-WEAR DAMAGE OBSERVED

The model presented in Table 1 does not include a scarring distribution believed to be diagnostic of a piercing action. The model does include distributions of striations associated with simple piercing and with piercing accompanied by a twisting motion. In simple piercing the striations run parallel to the axis of the tool. In piercing with a twist, the striations run parallel to the axis of the tool; these are cross cut by striations running parallel to the tip.

Six tools were used for piercing action; three for simple piercing and three for piercing with a twist. None of these tools developed striations during use. Therefore, they are all inconsistent with the model.

Macroscopically these tools did not develop any distinctive scarring pattern. For tools used for simple piercing, two showed no definite use related damage. The third tool developed a clean angular break on the first stroke which rendered the tool unusable. For the tools used for piercing with a twist, use tended to result in a single scar on the extreme tip at some point during use. One tool developed a single scalar scar which was subsequently erased by further use. One tool showed no definite use related damage until the last stroke. At that point the tip hinged off. The third tool initially shattered until a large scalar scar developed. This scar seemed to stabilize the tip. No further macroscopic use-wear damage developed during continued use.

MODEL VS. BORING USE-WEAR DAMAGE OBSERVED

The model presented in Table 1 states that tools used for the action of boring can be recognized macroscopically by scars appearing on the sides of the point rather than on the tip. The distribution of scars indicates either one-way or reverse action turning. Trapezoidal scars are associated with this action. At the microscopic level, tools used for boring can be recognized by striations running around the circumference of the tip and lying at right angles to the axis of the tool. The degree to which these striations are parallel to each other indicates both the hardness of the material worked and the method of boring. Hard materials yield more parallel striations than do softer materials. Bow drilling yields virtually parallel striations, while hand boring with either hafted or unhafted tools yields less parallel lines regardless of the direction and extent of the turn.

In the first experimental series, six separate tools were used for boring actions. All six were heavily bifacially retouched drills. Three of the drills were hand held and were used in 360° one-way turns. The remaining three were hafted and used for 180° reverse action turns. The hafting elements were rolled between the experimenter's hands. A bow was not used.

Of the six drills, only one or 17% yielded wear patterns consistent with the model. That consistency was seen only at the microscopic level. Shallow roughly parallel striations lying at a 90° angle to the tool's axis were observed on one of the hand held drills. The striations were sleeks rather than furrows.

At the macroscopic level, all six tools exhibited similar use-wear patterns. Five drill tips exhibited some degree of smoothing; one yielded a smooth glossy surface. The tip of the remaining drill shattered during use and exhibited a rough pebbly topography. Use related scarring was observed on only one drill tip. In that instance, a large bean-shaped scar formed midway through the working period. No trapezoidal scars were observed. All of the side margins of all of the tools showed no definitely use related damage.

Although these six tools show roughly similar patterns of macroscopic use-wear, the patterns are not a unique result of boring and, therefore, cannot be considered diagnostic of that action. The same patterning is observed on both perforators and gravers. Figures 11d - 11d' are the dorsal and ventral faces of a graver used for incising bone. The scarring distribution observed is consistent with and suggestive of a unidirectional boring action (as defined in

Table 1) despite the fact that that was not the action performed. Figures 12b and 12b' are the dorsal and ventral faces of a tool used to pierce tanned hide with a single downward motion. The use-wear scarring on its tip is consistent with and suggestive of the model for a reverse action boring motion; this was not its use. Figures 13b and 13b' are the dorsal and ventral faces of a drill used to a reverse action boring motion on oak. Only use wear scars are illustrated in the figures. The actual tool is heavily bifacially retouched making the illustrated use-wear scars virtually indistinguishable. The pattern of use-wear scars on the sides of the tip were not apparent until they were superimposed on the original drawing of production and incidental damage. At this level, the pattern is consistent with the model. However, the pattern of the pre-existing incidental damage, while not as extensive, is also consistent with the model for reverse action boring (Figures 13a and 13a'). The scarring on the tip of the drill, however, is inconsistent with the model; this type of damage should, according to the model, not occur in this position.

MODEL VS. CHOPPING USE-WEAR DAMAGE OBSERVED

The model presented in Table 1 does not discuss macroscopic components of use-wear damage associated with chopping actions. Microscopic use-wear damage associated with chopping varies according to the tool form and type of chopping activity. Patterns associated with hoeing are striations angling to and intersecting with the axis of the tool and are more prominent on the outer face. If the outer face of the hoe is convex, this can result in a fan-shaped pattern of striations. The pattern associated with adzes is striations parallel to the axis of the tool and more prominent on the forward facing surface of the adzes. The patterns associated with axes are uniform on both faces of the tool; striations run diagonally away from the cutting edge.

In the first experimental series, eight tools were used for chopping actions; three of these are morphologically classified as hoes, three are adzes, one is a wedge, and one is a cleaver. Due to hafting problems, no tools of the shape class axe were used.

No striations were observed on any of the tools used for chopping actions; therefore, none of the use-wear patterns on these tools are consistent with the model.

There is little commonality among the macroscopic use-wear traces observed on the various tool forms. The differences seem to relate to the density of the material worked, the degree to which the tool penetrated the material, and the chert type.

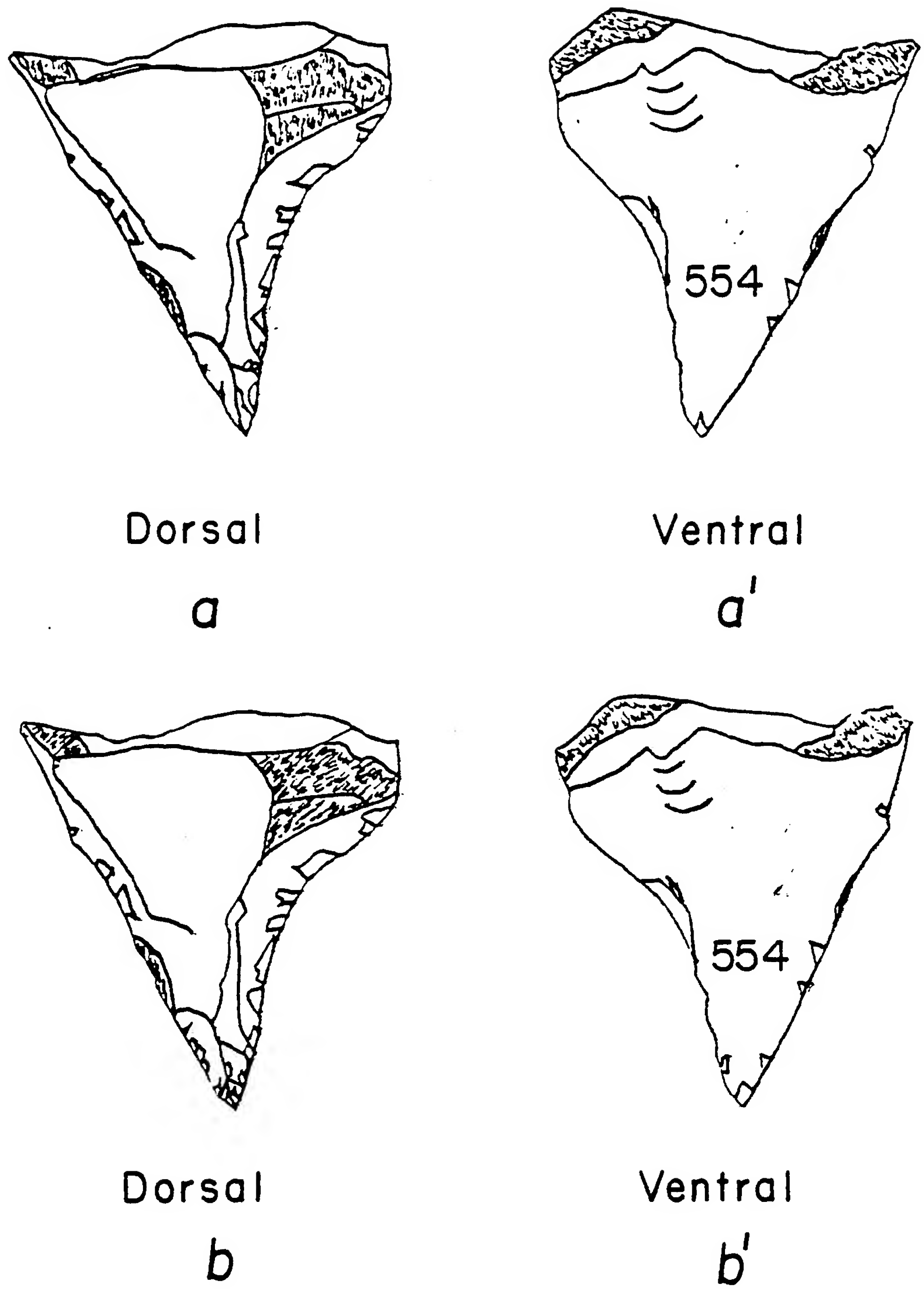

Figure 12. Record of macrowear damage on a perforator used to pierce tanned hide - a, 1' before use; b, b' after use.

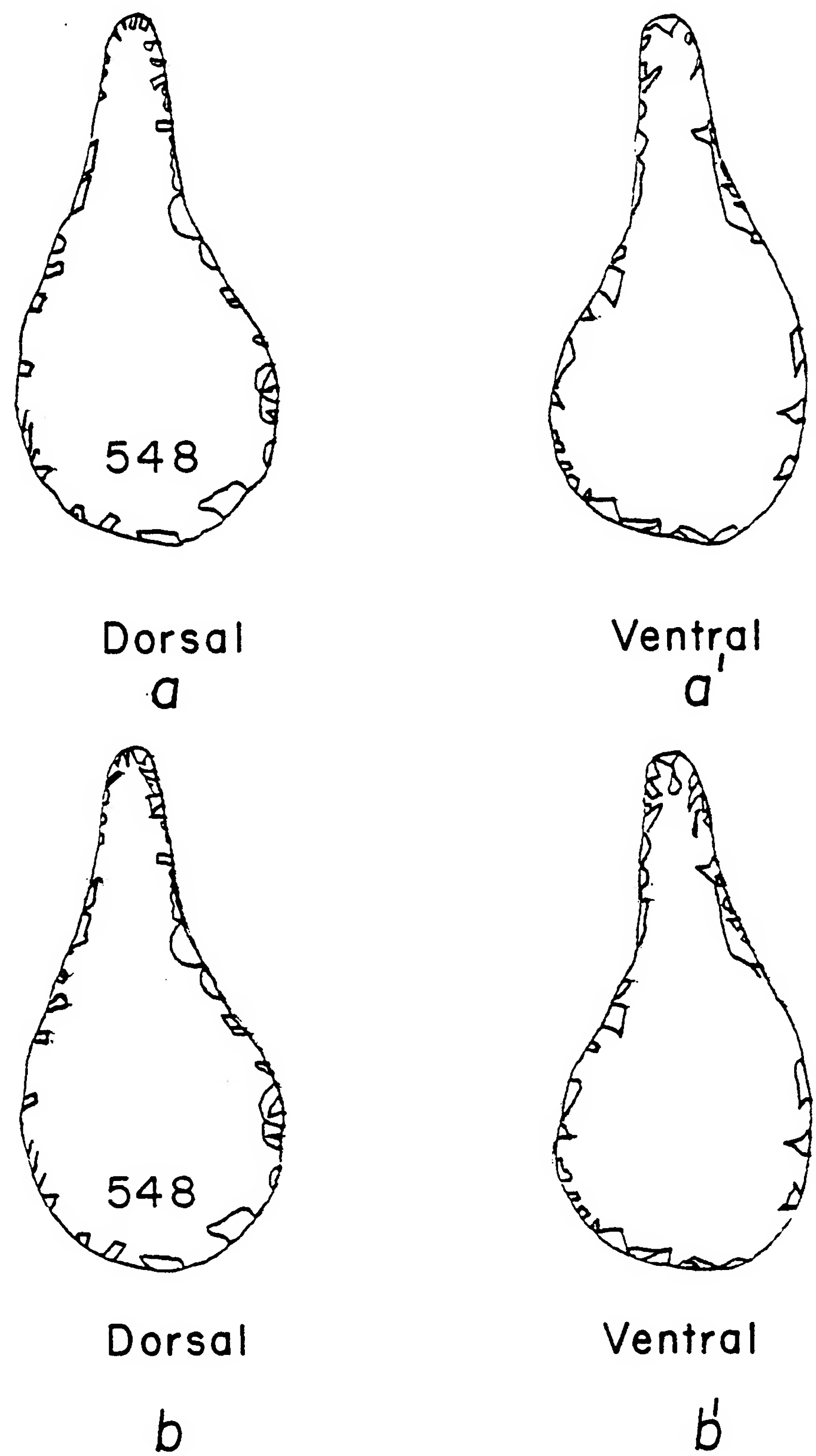

Figure 13. Record of macrowear damage on a drill used to drill wood - a, a' before use; b, b' after use.

The hoes were used to chop sod composed of dirt, dry and living grass, and small stones. The soil was a sandy clayey loam. The working edge of the Burlington hoe showed smoothing, complex scarring on both faces, and a faint sheen suggesting polish development on the dorsal surface. Use-wear observed on the Chouteau hoe included a faint sheen barely discernible from the texture of the unaltered chert surface and small to medium trapezoidal and rectangular scars. The scars are more prominent on the dorsal surface. In terms of the model, the trapezoidal scars are unexpected. This scar shape is believed to be associated with boring action (Table 1) and/or sawing wood (Table 2). The Jefferson City hoe is made of fine and coarse grained banded chert. There is obvious polish development on the fine grained side of the working edge. Also found in that area on the dorsal face are irregular, scalar, rectangular, and amorphous scars. No definitely use related scarring was observed on either the coarse grained side of the dorsal face or on the ventral face. As the above descriptions indicate, hoes in this collection used in the same manner on the same materials vary widely in use-wear forms and combinations and thus have no diagnostic value.

The use-wear forms observed on the adzes were more internally consistent for the tool type. However, due to their nature, they are of limited value. All of the adzes were used to hollow an oak log. Both the Burlington and Chouteau adzes exhibited a gloss suggesting polish development and massive use related scars resembling the larger intentional retouch scars on the same tools. The working edge of the Jefferson City adze exhibited massive complex scars also resembling retouch; however, these were smaller than those observed on the other adzes. On archeological examples, it would be extremely difficult to impossible to distinguish such use-wear forms from intentional retouch.

The single cleaver in the first experimental collection was used to chop through fresh bone. Both the macro- and microscopic components of use-wear damage observed are inconsistent with the model and are of limited diagnostic value. Crushing and crushing with debris were observed. These, as will be discussed more fully in a following section, are the most common forms of wear observed in this collection and are universal regardless of tool form, chert type, action performed, or material worked.

The wedge was also used for splitting bone. Due to tool and percussor efficiency problems, use time for this tool was short. Therefore, the observed use-wear may not represent that associated with wedges used for chopping actions of longer duration. Major crushing was observed on both the striking platform and the working edge. Additionally, complex terminated scarring was also observed on both

faces of the edge. As in the other cases described in this section, this scarring was indistinguishable from that observed before use.

Microscopically, all of the tools used for chopping, regardless of shape class, exhibited crushing and complex scarring. These forms are also found on other tool forms used for different actions and, therefore, cannot be considered diagnostic of chopping.

MODEL VS. POUNDING USE-WEAR DAMAGE OBSERVED

The model presented in Table 1 does not discuss the macroscopic or microscopic components of pounding use-wear damage. In fact, pounding as a separate action is a creation of this experimental series.

Three tools were used for pounding actions, i.e., for high impact actions resulting in little or no penetration of the material being worked. Two of these tools were hammerstones, and one was a wedge. Under normal circumstances wedges are used for chopping actions; however, in this instance, because of the extreme resistance offered by the cane being worked, the action performed with this wedge can only be termed pounding.

Both hammerstones exhibited highly localized macro- and microscopic crushing appearing as star-shaped patterns formed at the point of impact. The wedge, because of the differing configuration of its working area, exhibited crushing and complex scarring both macro- and microscopically. As can be seen by the preceding and following sections, these use-wear forms are not diagnostic of any particular action.

Use-Wear Evidence Observed for Multipurpose Tools

The model and the available use-wear literature used for this paper do not include any method for identifying multi-use tools. Tringham et al. (1974: 193) supply some thoughts regarding this question which were not tested by their experiments. These thoughts are resorts to logic and include the expectations that "heavier tasks" succeeding "lighter" tasks will obliterate the evidence of the "lighter" and that in instances where a single tool was used first for longitudinal action and then for transverse action, the tool will retain vestiges of both because of the differential distribution of the relevant use-wear traces.

MODEL VS. CUTTING AND SAWING USE-WEAR OBSERVED ON THE SAME TOOL

These thoughts are of little assistance in evaluating tools where the same edge was used for both types of

longitudinal action, i.e., cutting and sawing. In the first experimental series, five tools were used for the multiple actions of cutting and sawing. The shape classes used included flake, biface, and denticulate. Macroscopically, all of the tools were uninformative in terms of use-wear damage. The flake and the three bifaces showed no definitely use related damage. One tooth of the denticulate, which had originally been squared, broke during use, leaving a triangular shape. There was no other evidence of definitely use related damage on this tool.

Microscopically, all five tools exhibited crushing, and all four of the bifacially modified tools exhibited complex scarring. Only two tools, one flake and one biface, showed unequivocal evidence of longitudinal action; only the flake showed the expected indicators of cutting and sawing. The biface had striations running along the extreme edge. This is indicative of longitudinal movement but will not suffice to differentiate cutting and sawing. The flake shows evidence of both cutting and sawing as described in the model. There are small snap scars along the entire length of the working edge. These are associated with sawing. In addition, there are also small scalar scars on both the dorsal and the ventral surfaces. However, the distribution of these scars is consistent with cutting only on the ventral face. If this tool had been an archeological specimen rather than an experimental tool of known use, it would in all probability have been interpreted as a saw because the evidence of cutting was so slight.

MODEL VS. CUTTING AND TRANSVERSE CUTTING USE-WEAR DAMAGE OBSERVED ON THE SAME TOOLS

As noted above, the model presented in Table 1 provides no evidence for interpreting the use-wear damage observed on tools used for both cutting and transverse action. Tringham et al.'s thoughts on the subject suggest that the damage from the two forms should be easily discernible because of their distribution. The results of this experimental series do not confirm this expectation.

Eight tools were used for the combined actions of cutting and transverse cutting in this experimental series. The shape classes represented included scraper, flake, and biface. All of the tools were used to process fresh hide. The combination of actions arose naturally in the course of performing the task and are a reflection of the actions suited to removing flesh from hide.

At the macroscopic level none of the tools exhibited the expected damage traces. Five of the tools showed no definitely use related damage. These included examples from the shape classes flake and biface. Two of the tools, one

scraper and one flake, showed rounding and snap scars along the entire working edge. Contrary to expectation and suggestion, there was no localized damage associated with transverse cutting. This is probably because the areas used for cutting and for transverse cutting were virtually the same.

This occurrence was repeated at the microscopic level for the three tools which exhibited some evidence of action vis a vis use for an unidentifiable action. In all three instances, only evidence of lateral movement was observed. This included scarring patterns consistent with cutting or with sawing, and striations or lineal crushing and polish formations consistent with those actions. No evidence indicative of transverse cutting was observed. If these tools had been archeological specimens, the evidence would have dictated that they be interpreted as either knives or saws; their actual dual purpose would have been lost.

Discussion of Relative Hardness Indicators Vs. Use-Wear Damage Observed

The literature indicates that macroscopic use-wear damage is believed to be capable of determining the relative hardness of the materials worked with particular tools. The relative hardness scale for macroscopic use-wear damage is presented in Table 2 of the model; the scale defines use-wear traces for soft, medium, and hard materials. The following subsections summarize the observations of use-wear traces observed in the first experimental series and their degree of consistency with the model.

SOFT MATERIALS

The model designates meat, fresh and dry or tanned hide, plants and fish as soft materials. It also states that soft materials yield only scalar scars. These scars are generally small with slight nibbling being the upper level of the size range. Fish scales offer the most resistance of all the soft materials; they yield more clearly defined scalar scars.

Thirty-three tools were used to process soft materials in the first experimental series. The materials processed included meat, fresh and tanned hide, grasses, and Jerusalem artichokes. If one adheres strictly to the model's dictum that only small scalar scars form when working soft materials, none of the tools are consistent with the model. If the model is expanded to include small snap as well as scalar scars, four or 12% of the tools are consistent with the model. Of the remaining 29 tools which are inconsistent with either alternative, 17 or 51% show no definitely use related damage, 1 or 3% shows complex scarring, 1 or 3% only striations, and 4 or 12% medium to large scalar scars.

The model for measuring the relative hardness of the materials worked is restricted to macroscopic scarring; therefore, the microscopic scarring observed on the tools from the first experimental series will not be discussed.

MEDIUM MATERIALS

The model presented in Table 2 designates hard and soft woods as medium materials. The model states that wood working produced four distinct scar shapes; scalar, snap, triangular, and trapezoidal. Trapezoidal scars, according to the model, occur only when working wood and generally only when a sawing action is performed. The model also notes that hard wood may eventually yield small stepped scalar scars. Scars produced by wood working have finely abraded or fuzzy margins. Because the model designates only wood as a medium density material, it is unclear whether the defined scar types should be expected for other medium density materials.

The second experimental series added two other medium density materials to the list presented in Table 2. They were dried river cane and soil. Unlike the others, the medium density designation for soil is a relative average of its components. The soil processed for this experiment was a sandy clayey loam. In a damp state the soil itself was relatively soft. However, included in it were root masses, plant growth and miscellaneous rock in addition to the tiny sand grains. These inclusions and the soil itself when dry proved to be highly resistant when worked. Because the hard, medium and soft inclusions were mixed equitably throughout the material, its hardness was averaged rather than designated individually. This was done only for this one material.

A total of 33 separate tools were used to process medium density materials in the first experimental series. Of these, 13 or 39% developed use-wear scars of the types discussed in the model. However, these scarring types were the only primary use-wear form observed for 4 of the tools or 12% of the total sample. For 8 of the 9 remaining tools, attrition was the primary use-wear form with the scarring being slight and infrequent. Four small scalar scars were observed on the ninth tool; while the scar shape is consistent with the model for medium density materials, the size range is that defined for soft materials in Table 2.

Among the 16 tools which were inconsistent in all respects with the model, 2 showed no definitely use related damage; 3 initially shattered and then formed only attrition wear forms, 2 had only complex scarring and 13 had combinations of attrition, complex scarring and crushing with debris.

The remaining three, all adzes used to hollow a hard wood log, exhibited unexpected wear patterns which place the classification of hard wood as a medium density material in question. All three tools were used for a high impact activity. The combination of that activity and the resistance of the material worked produced use-wear scarring of the same size and characteristics as the intentional retouch found on the same tools.

In contrast, the 3 hoes used for chopping sod were used for a high impact task but on a much less resistant material. Two of the four tools, which were virtually consistent with the model for medium density materials, were hoes.

On this basis, hard wood was classed as a hard rather than medium density material for purposes of evaluating the blind test series.

Because of the properties of the three chert types used in the first experimental series (see section on chert types), the characteristics of the scar margins have no bearing on the density of the materials worked and are not considered here.

HARD MATERIALS

The model presented in Table 2 states that hard materials tend to produce step (or terminated) scars which gradually obliterate the original scalar scars. The rear margins of all scars, regardless of type, are clearly defined. After working hard materials, the working edges of the tools are irregular and have numerous projections. Working antler produces the greatest amount of edge destruction. Bone working produces mainly large scalar scars.

Hard materials as defined by Table 2 include only bone and antler. In the first experimental series the additional materials, clam shell and stone, were added to the list of hard materials.

A total of 29 tools were used to process hard materials in the first experimental series. Of these 15 were used on bone, 9 on antler, 3 on shell and 2 on stone. Because the expected use-wear patterns for bone and antler differ and because shell and stone were not treated in the model, tools used to process each material will be treated separately.

Of the 15 tools used to process bone, only 1 or 7% of those tools was consistent with the model. Of the remaining 14, 4 exhibited no definitely use related damage, 3 exhibited crushing both with and without debris, 1 showed a combination of attrition and crushing, 4 only attrition, 1 complex

scarring, and 1 complex scarring which is probably an artifact of manufacture. These results indicate that these tools have no consistent constellation of damage independent from the model, but still internally consistent for working bone.

The 9 tools used to process antler are difficult to assess in terms of the model. The antler used by Tringham et al. (1974), when defining the scarring associated with this material, was fresh. No fresh antler was available for use in the first series of experiments; instead seasoned antler was soaked in water for three days in accordance with the procedure followed by Keeley and Newcomber (1977) to render the same material workable.

Although there is precedent for such a procedure, antler soaked in water presents a different range of density than does fresn antler. The outer layer of antler which has been soaked in water is very soft and offers little more resistance than meat or hide and much less than that offered by fresh soft wood. As processing removes this layer, the antler becomes harder and comes closer to the consistency of fresh antler.

Of the nine tools used to process antler, only two or 22% are consistent with the model presented in Table 2. Both of these tools were used for sawing antler. They both showed massive and swift attrition, leaving a smooth undulating edge. Each of these tools penetrated the antler far beyond the soft outer surface.

The third inconsistent sawing tool was made from Chouteau chert which, as noted in the section on chert, tends to fracture repeatedly rather than presenting a stable surface amenable to the development of attrition damage.

The three scrapers or 33% of the antler tool kit were used to plane antler. The contact material for these tools was primarily the soft water-logged outer surface of the antler. Macroscopic damage observed on these tools was inconsistent with the model for antler. Two of the scrapers exhibited no definitely use related damage. The third tool showed complex scarring on its retouched face (probably an artifact of manufacture) and a slight, barely perceptible trough on its unretouched contact face. In contrast, 5 of the 10 tools or 50% of the tools used to plane wood exhibited well developed troughs on their contact surfaces. This confirms the observation that the hydrated outer layer of the antler used in this experiment is more properly designated as a soft material.

The gravers used to process antler did not exhibit any greater damage than that observed for either bone or

shell. In all instances, the fracturing followed by severe attrition believed to be diagnostic of all gravers in this experimental series was observed. As noted in the subsection on graving actions above, this damage pattern is primarily indicative of graving actions with the graving tool form found in this collection and not of the relative hardness of the material processed.

The two tools used to process stone are unique to this collection and are not discussed in the model. There is no commonality of use-wear traces noted for the tools used to process stone. This is due more to the nature of the raw material than to the material processed.

One of the stone processing tools was a Jefferson City core used as a hammerstone. It was used to drive a stone wedge through bone. The area of impact was localized and the force employed was heavy. The damage noted was entirely crushing with white powdery debris; the damage was not extensive. The observed crushing did not differ materially from that observed on other Jefferson City tools used on other materials.

The second tool used to process stone was a sandstone slab used to abrade the edge of the drills in order to facilitate hafting. Deep V-shaped grooves formed in the slab. No scarring was observed. Instead, it appeared that the individual sand grains had broken away from the matrix along the lines of force.

MULTI-DENSITY MATERIALS

Twelve tools in the first experimental series were used for tasks which brought them into contact with both hard and soft materials. Ten were used in butchering and came into contact with hair, hide, meat, ligaments and connective tissue. The remaining two were used to scrape fresh hide and also came into contact with the plywood and plastic used to protect the work area.

At the macroscopic level only 1 or 8% of these tools developed identifiable use-wear damage. Five large scalar scars were observed on a scraper used to clean mean and connective tissue off of bone. The scarring is consistent with that defined for bone. This suggests that where the contact materials have different densities, the use-wear observed will reflect only the hardest materials. However, one example is insufficient to state this conclusion with any certainty.

The use-wear observed on the two multi-density hide processing tools does not differ materially from that observed on the tools used only to scrape fresh hide. This

does little, however, to invalidate the suggestion made above. The time spent in contact with the plastic and the plywood was slight in comparison with the time spent in contact with the hide. In these instances, use-wear associated with the material with the longest contact period over-rode use-wear associated with the material with the shorter contact period in spite of the greater density of the latter material.

Discussion of Model Polishes Vs. Observed Polishes As An Indicator of Material Processed

Polish formation and identification in the first experimental series are less than optimum. As noted above in the section on the influence of the chert types, the characteristics of the cherts themselves are not amenable to the formation of well developed polishes.

In addition, there are technical problems which influence the quality of the observations described in the following subsections. In numerous instances listed in Table 4, resolution of some chert surfaces, including treated surfaces, was so poor that it was impossible to describe polishes present on some tools and may have prevented the observation of polish in other instances.

The description and identification of polishes observed in the first experimental series are severely limited by the capabilities of the Bausch and Lomb Stereo-Zoom 7 microscopes utilized. With 10X occulars or a camera attachment the maximum available magnification is 70X. This magnification level can be raised to 140X by the addition of a 2X supplemental lens. However, 70X is the upper limit for clear photomicrographs with the available equipment. Accordingly, the observational range was limited in large part by the need to photographically record the observations described.

A combination of the 15X occulars and the 2X supplementary lens produces a magnification range of between 30X and 210X for this equipment. The upper portion of this range was used for a minority of the tools in the first experimental series. At magnifications above 70X, the oolitic Jefferson City and the Burlington tools present such severe resolution problems that accurate and detailed observations are impossible. These chert types account for roughly two-thirds of the first experimental tool kit.

For this reason and because comparison of observations of polishes among the three chert types required that they be made at the same level of magnification, all of the comparative observations were made between 40X and 70X. The highest possible magnification was always used.

This, however necessary, presents problems in assessing the degree to which the observed polishes correspond to the definitions found in the literature. The literature states that the minimum acceptable level for the observation of micropolishes is 300X (Keeley 1977: 111; Keeley and Newcomber 1977: 36; Newcomber and Keeley 1979: 199). The observational range used in the first experimental series falls far below this minimum, and the available equipment could not reach the minimum level even if clear observations could have been made at the upper limits of the available magnification.

With these limitations in mind, the following is an analysis of the polishes observed in the first experimental series and a comparison of those observations to the descriptions included in the literature.

MEAT POLISH

According to Table 2, meat polish provides little contrast to the unaltered chert surface. It is relatively dull with a pronounced greasy luster. The minute elevations and depressions of the chert are retained.

In the first experimental series, four tools were used exclusively to process meat. None of the polishes observed were particularly extensive or well developed. In two instances, a greasy matte polish was observed (Plate 3c). In one of these instances the distribution of the polish resembled luminous dots.

On the third tool, polish was more extensive. It was bright and luminous and filled the depressions on the chert surface. The difference in brightness may have been a result of the unaltered chert surface. The tool was made from a high quality Chouteau chert which, in its unaltered state, has a smooth texture and pronounced sheen (Plate 2d). This is not necessarily the cause, because one of the tools on which a greasy matte polish was observed was made from the same chert.

No polish was observed on the working edge of the fourth tool. However, an area of greasy matte polish was observed on the dorsal face in an area which had not come in contact with the meat. A review of the experimental notes indicated that the operator's ungloved thumb had rested in that area while utilizing the tool. This then was a finger or hand print like that described by Semenov (1964: 5). No particular effort was made to isolate other finger prints in the first experimental series; however, several were noted while evaluating the blind test series. They were consistent with the one described here. Plate 3d illustrates one of these finger prints.

FRESH HIDE POLISH

As described in Table 2, fresh hide polish is a greasy slow forming feature similar to that described for meat. It is sometimes accompanied by diffuse linear features similar to striations. This polish becomes more pronounced as the hide becomes drier.

A total of eleven tools were used to scrape fresh hide. Some polish development was observed on nine of the tools. In all instances, the polish had a dull matte sheen similar to that observed for meat but slightly less bright. This polish configuration is consistent with the model.

Linear areas of crushing were observed on the contact surfaces of three tools including one on which no polish was observed. These features are consistent with the diffuse, striation-like features described in Table 2.

DRY HIDE POLISH

Dry hide polish as described in the model is a dull matte polish which occasionally has tiny "pot lid" type pits in its surface. It may also be accompanied by the linear features described for fresh hide polish.

A total of six tools in the first experiment were used to pierce holes in tanned hide. Polish development was so minimal on three of the six that its characteristics could not be described. No polish was observed on two of the tools. The polish observed on the final tool was a dull sheen barely distinguishable from the unaltered chert surface (Plate 3a). No "pot lid" or striation-like features were observed.

PLANT POLISH

The model states that plant polish has a very smooth highly reflective surface. The polish is fluid and appears to flow over the surface of the tool. Striations, when present, are generally filled in. Comet-shaped pits sometimes occur.

A total of thirteen tools were used to process plant materials, excluding wood, in the first experimental series. The plant materials processed included grasses, Jerusalem artichokes, and dried river cane. Differences in polish development were noted for the three materials. They will be described in detail by the type of plant material processed.

Six tools were used to reap grass. No polish was observed on two of these, and two showed faint polish development. The polishes observed on the remaining two were very

bright and fluid and consistent with the model. Plate 3f is an example of this type of polish.

Six tools were used to peel and slice Jerusalem artichokes. The polish derived from these tubers differed markedly from that observed for the grasses. While the polishes were not well developed in all instances, they were always more extensive than that associated with grass. Also, polish of some magnitude developed on all of these tools in contrast to the grass processing tools. In the two instances where polish was well developed, it was very bright but lacked the fluid appearance of the grass polish.

One tool was used in an attempt to split dried river cane. The operation was short lived and unsuccessful. No polish was observed on this tool.

SOIL POLISH

The model does not discuss polish associated with hoeing operations and, therefore, provides no guidance for interpreting such polish.

Three tools in the first experimental series were used for chopping sod. This was done on the assumption that digging operations could occur as easily in a gathering context as in an agricultural one.

Very bright plant polish was observed on the working edges of all three hoes. While it is possible that the polish is the result of the plant and root materials in the sod, evidence from the blind test series, which will be discussed later, suggests that the polish is the by-product of the soil particles themselves.

The soil polish is virtually indistinguishable from plant polish. See Plates 3f, 2c, and 4b for comparison of the two polishes.

WOOD POLISH

The model presented in Table 2 indicates that wood polish is consistent whether it is produced by hard or soft wood. The resulting polish is very bright with a smooth texture. Well developed polishes have an undulating surface with the troughs and crests running in the direction of the line of force.

A total of 29 tools were used to process wood in the first experimental series. No polish was observed on 11 of the 29. Of the remaining 18, 6 exhibited polishes which were sufficiently well developed to permit description. All

six had bright polishes virtually indistinguishable from the plant polishes described above. Plates 2e and 4c show wood polish which matches the plant polish shown in Plate 3f.

BONE POLISH

Bone polish, as described in Table 2, is bright and has an uneven pitted texture. Bone polish is slow forming and is seldom extensive. It forms only on the elevations of the chert and does not link or spread. Its most distinguishing feature is numerous pits less than 1 micron in diameter on the polished surface.

Fifteen different tools were used to process bone in the first experimental series. No polish was observed on 5 of the tools and 2 tools had such poorly developed polish that it could not be described. On the remaining 8 tools polish, which looked like clusters of luminous white dots, was observed. The dots were always clearly individual regardless of the extent of polish development. This is consistent with the model. The magnification was not high enough to isolate any of the pitting features diagnostic of bone polish.

ANTLER POLISH

The model defines two distinct kinds of antler polish. They are the product of different modes of action performed on antler.

Smooth antler polish is formed by planing, scraping, or graving antler. In its early stages of development, it is virtually indistinguishable from wood polish. When well developed, smooth antler polish is pocked and resembles a melting snow bank.

Rough antler polish is a product of sawing antler. It is similar to bone polish but lacks the pot lid features associated with bone.

In the first experimental series, nine tools were used to process antler. Six of these were used for actions which should produce smooth antler polish. On one of these tools, no polish was observed; on three others, polish was present but unidentifiable. Very bright polish was observed on the remaining two tools. This polish was observed only on the projections of the graver; the polish observed on the scraper was bright and fluid, like that observed for plants. This conflicts with the model.

Three tools were used for sawing antler. No polish was observed on any of these tools; therefore, no comparison with the model is possible.

SHELL POLISH

The model did not discuss polish produced by working shell. In the first experimental series, three tools were used to grave shell. Polish was observed on only one of the tools. This polish was very bright and covered both the projections and depressions of the chert surface. This polish is virtually indistinguishable from wood polish and the polish associated with Jerusalem artichokes.

MULTI-PURPOSE POLISH

The model presented in Table 2 is restricted to polishes derived from processing only a single generic material. Twelve tools in the first experimental series were used for tasks which brought the tools into contact with more than one generic type of material. Ten of the tools were used for butchering activities and came into contact with hair, hide, meat, connective tissue, ligaments, and bone.

No polish was observed on three of the tools, and slight unidentifiable polish was observed on two others. Polishes observed on three of the tools were the luminous white dots associated with bone in this experimental series. The polish observed on one tool was the greasy matte luster associated with meat. On one tool both bone and meat polishes were observed.

There is no easy explanation for the differences in the polishes observed. While there were differences in the duration of use for the tools, this does not appear to be a controlling factor. For two tools used for the same length of time on the same combination of materials, one exhibited only meat polish and the other both meat and bone polishes. The answer probably lies in the uniqueness of each tool-to-material contact; the information available from the notes on these experiments is insufficient to establish the answer.

Two tools were used primarily for scraping fresh hide. During this process, the tools also came into substantial contact with the plastic and plywood used to protect the work area. However, this additional contact did not seem to have any effect on the polishes observed. One of the tools had slight poorly developed polish; the other had isolated areas of dull matte polish like that observed on the other fresh hide processing tools.

Discussion of the Chert Type Variable

As noted in the model section, the cherts indigenous to the reservoir area differ in their texture and grain size. Of the cherts used for the first series of experiments, Chouteau had the finest texture and smallest grain size. The

best quality examples show a noticeable sheen in their unutilized state (Plate 2d). Not all of the Chouteau chert found in the reservoir area or used in this experiment is of that quality. Plate 2f shows the texture of unutilized Chouteau with a grainier texture. The Jefferson City chert used in this experimental series holds the medial position in terms of texture and grain size. A high percentage of the Jefferson City tools in the experimental sample is oolitic. Plate 4a is an example of the unaltered surface of this variety of chert. The Burlington chert both in the reservoir area and in the first experimental tool kit has a rough large-grained texture. There are severe resolution problems when magnifying this chert. Therefore, no photographic examples of its texture are available here.

Despite the differences in their texture, the differences in their use-wear patterns are surprisingly subtle. A survey of the frequency with which the macroscopic scarring versus attrition damage types were observed on the first series of tools indicated that there was no significant difference among the three chert types. For both Chouteau and Jefferson City 45% of the observed occurrences of specific forms of use-wear damage were scarring types. The frequency of scarring damage on the Burlington tools was 46%.

A further examination of the tools indicated that the differences in the scarring observed on the three types of chert were more a function of quality than of kind. The scars noted for the finest grained Chouteau tended to be well defined with acute margins both at the sides and the back. These scars were also more apt to be terminated with either hinges or steps. The scars noted on the Jefferson City examples also tended to be well defined especially at the back. They were less likely to be terminated and more apt to be feathered. The Burlington tools had scars with fuzzier or indistinct margins both at the sides and the back. It appeared that the lines of fracture ran around rather than through the grains. The interiors of the scars were very similar to the pebbly surface observed in the grooves on the sandstone abrader.

While grain size has no discernible effect on the frequency of scarring versus abrasive wear, it does seem to have some effect on the overall development of use-wear traces. The best example of this is tool 216, a Jefferson City hoe used to chop soil containing grass roots and miscellaneous small rocks. This tool was made of banded chert. The banding bifurcated both the dorsal and ventral faces of the working edge approximately in half. The right half of the dorsal face was fine grained chert; the left half of the dorsal face had a coarse grained, rough surface. The use-wear traces observed on the right half included a high gloss polish and a concentration of stepped scars of

triangular, scalar, rectangular, and amorphous shapes. No polish or definitely use related scarring was observed on the coarser left half. This difference in damage formation must be attributed to the difference in original grain size and texture; this is the only variable in the use of tool 216.

There is also a consistent difference in the amount and character of the overall breakage patterns observed among the different chert types. In summary, Chouteau shatters and fractures most easily and often presents the least stable working edge. Burlington does not fracture so much as it crumbles. Where fracturing occurs, it tends to be complex. Burlington working edges become dull and inefficient sooner than those for the other two types. Jefferson City fractures less and more slowly than Chouteau, yielding numerous observations of "no definitely use related damage." Where use-wear scarring does occur, it tends to be individual identifiable shapes.

This pattern is illustrated by the bifaces used to saw seasoned oak. For tool 539 (Chouteau), edge attrition was massive and swift. The edge was heavily damaged and dull at the end of two minutes use time. Tool 113 (Jefferson City) was still sharp after ten minutes working time. Its originally step fractured edge was smoothed with some of the scar obliterated. The obliterated step fractures were replaced by back to back scalar then rectangular scars conforming to the model for sawing actions. Complex scars were observed on both faces of tool 809 (Burlington). During use, scars of identifiable shapes were observed; but as they accumulated, they were no longer distinguishable.

A similar pattern was also observed in situations producing primarily attrition use-wear features. The three hand held drills used on seasoned oak are an example of this feature. The tip of tool 546 (Chouteau) audibly fractured at the beginning of the drilling action. No identifiable scar form was observed. Continued use produced crushing damage on the extreme tip. Slight smoothing was the only use-wear observed on the tip of tool 214 (Jefferson City). The tip of tool 828 (Burlington) was also slightly smoothed after use.

Although the breakage patterns described above are generally true, they are subject to more variability and inconsistencies than are the patterns described below.

An additional facet of the relative differences in breakage patterns for the three chert types is their differential tendencies to display the scarring distributions consistent with the model presented in Table 1. Of the eight tools in the first experimental series which were consistent

with the model at the prescribed macroscopic level, four or 50% were made from Jefferson City chert. Of the remaining four, two or 25% were made from Burlington chert, and two or 25% were made from Chouteau chert. Because the number of consistent tools was so small (8 of 107 or 7.5%), this differential has little predictive value in assessing archeological collections from the Truman Reservoir area.

Polish, regardless of variety, forms first and is most well developed on Chouteau chert. Polish forms least often and least well on Burlington chert. Polish forms slower on Jefferson City chert; but, given enough time and the right conditions, the polish is well developed.

For example, of the three denticulates used to saw bone, no polish was observed on tool 810 (Burlington), a few patches of well developed definable polish were observed on tool 526 (Chouteau), and very slight but definable polish was observed on tool 203 (Jefferson City). The use time for tool 203 was substantially shorter than those for tool 810 and tool 526.

This difference in use time does not, however, alter the pattern of polish development observed for these three chert types. For three tools used to scrape fresh hide, isolated patches of dull matte polish were observed on the edge and surface of tool 505 (Chouteau biface); the same polish was observed along the extreme margin of the ventral edge of tool 135 (Jefferson City, scraper); a weaker version of the same polish was observed on the extreme edge of the same tool; and very slight poorly developed polish was observed only on the dorsal face of tool 735 (Burlington, flake). In this instance both tools 505 and 135 were used for the same length of time. Tool 738 was used for a one-third longer period which probably accounts for the appearance of polish on that tool.

The differences in shape class for the examples reviewed above do not appear to affect the degrees and rates of polish development for the respective chert types. The same pattern was observed on the three perforators used to pierce tanned hide with a twisting motion. In this instance, all three tools were of the same shape class, had the same relative amounts of retouched and unretouched areas, and were used for exactly the same length of time. The unretouched ventral surface and retouched projections of tool 553 (Chouteau) had a polish with a dull sheen; tool 219 (Jefferson City) had minimal polish development on the projecting portions of its retouched areas and of its unretouched but rough ventral surface; faint indeterminant polish was observed on the extreme tip and unretouched dorsal surface of tool 819 (Burlington).

This pattern of polish development suggests that polish formation is dependent upon a smooth surface and that extensive well developed polishes cannot be expected on grainier materials, such as Jefferson City and Burlington, until sufficient abrasion has occurred to yield the necessary smooth surface.

The texture or relative smoothness of the chert surface also has an effect on the formation of striations. Three flakes, one of each chert type, were used to peel and slice Jerusalem artichokes using only cutting actions. Striations were observed only on tool 569 (Chouteau) in spite of the fact that its use time was the shortest of all the tools utilized for this task. The classic cutting distribution of small scalar scars, but no striations, was observed on tool 241 (Jefferson City). Tool 848 (Burlington) suffered only obvious edge reduction or attrition.

Discussion of the Tool Form Variable

As noted in the introductory and model sections of this paper, all of the defined use-wear forms and distributions were defined for flakes or minimally modified tools. Because the Truman artifact collections are composed overwhelmingly of bifacially or heavily retouched tools, 71 of the 107 tools in the first experimental series are heavily retouched tools which can be classed generally as bifacial or unifacial. The following is a discussion of the effect of the varying planes of a retouched surface on the definitions derived for the single plane of an unretouched surface.

Two or 25% of the eight tools which had macroscopic distributions of scarring consistent with particular actions were heavily retouched tools. One of these was a biface used for sawing seasoned oak. The other was a scraper used to plane bone. The scraper must be viewed with a degree of caution. Its dorsal face is the face in contact with the bone; this is also its heavily retouched face. The retouched face showed a mass of complex scars stemming from the intentional retouch. It is probable that the complex scarring obscured use-wear scarring on that face. This eventuality is strongly suspected because 15 of the other 21 transverse cutting tools or 68% of the sample had use-wear damage on the contact face.

This tendency of retouch to obscure macroscopic use-wear is confirmed by the fact that 40 or 56% of the 71 heavily retouched tools display no definitely use related damage at the macroscopic level. Three additional tools had retouch-like use-wear damage which would not have been recognized as use related in an archeological context. Identifiable use-wear damage was observed on the remaining 28 heavily retouched tools. However, the observations for

23 of these consisted of crushing, complex scarring, and general attrition which, while definitely use related, are not diagnostic of any action or any relative hardness of material. Thus 66 or 93% of the heavily retouched examples yielded no useful information regarding the way in which the tools were used to process various materials.

In contrast, 29% of the flakes or minimally retouched flake tools (as opposed to 7% of the heavily retouched examples) had identifiable scarring patterns that could be of some use in identifying actions and materials. In addition, 12 gravers, a minimally retouched form, showed attrition damage which when coupled with their physical configuration has been provisionally deemed diagnostic of graving actions for similar tools. This raises the unretouched and minimally retouched total of tools with informative use-wear traces to 22 of 34 or 65%.

The summary above is specifically illustrated by the six tools (3 bifaces and 3 flakes) used to reap grass. All six tools were used for the same action on the same materials, and each was used for the same length of time. No definitely use related damage was observed on tool 804 (Burlington, biface), while alternating groups of scalar scars consistent with cutting were observed for tool 846 (Burlington, flake). Similarly, only edge attrition was observed on tool 276 (Jefferson City, biface), while an alternating pattern of scalar scars consistent with cutting was observed on tool 228 (Jefferson City flake). The Chouteau examples vary from the other chert types. Edge attrition and snap scars were observed on tool 504 (Chouteau, biface) while complex scarring was observed on tool 565 (Chouteau, flake). This difference can be attributed more to the characteristics of the chert than to the form of the tools. As noted in the section dealing with the impact of chert type, it was noted that Chouteau is most susceptible to easy and frequent fracturing.

The impact of placement and extent of retouch on the formation of macroscopic use-wear traces can be seen by comparing bifacially retouched tools to unifacially retouched tools. Figures 14b and 14b' show the macroscopic use-wear damage observed on the dorsal and ventral faces of tool 554 (Chouteau, hoe), which was used to chop soil, grass, roots, and miscellaneous rock. Tool 554 is a bifacially retouched tool. The use-wear observed on tool 554 is concentrated and tends to be complex. The use-wear observed on the retouched face of tool 231 (Jefferson City, scraper) is similar in character and extent (Figure 15b). In contrast there was no use-wear damage observed on the unretouched ventral surface of tool 231 (Figures 15a' and 15b').

The total absence of use-wear on an unretouched surface is unusual. However, the difference is retained even

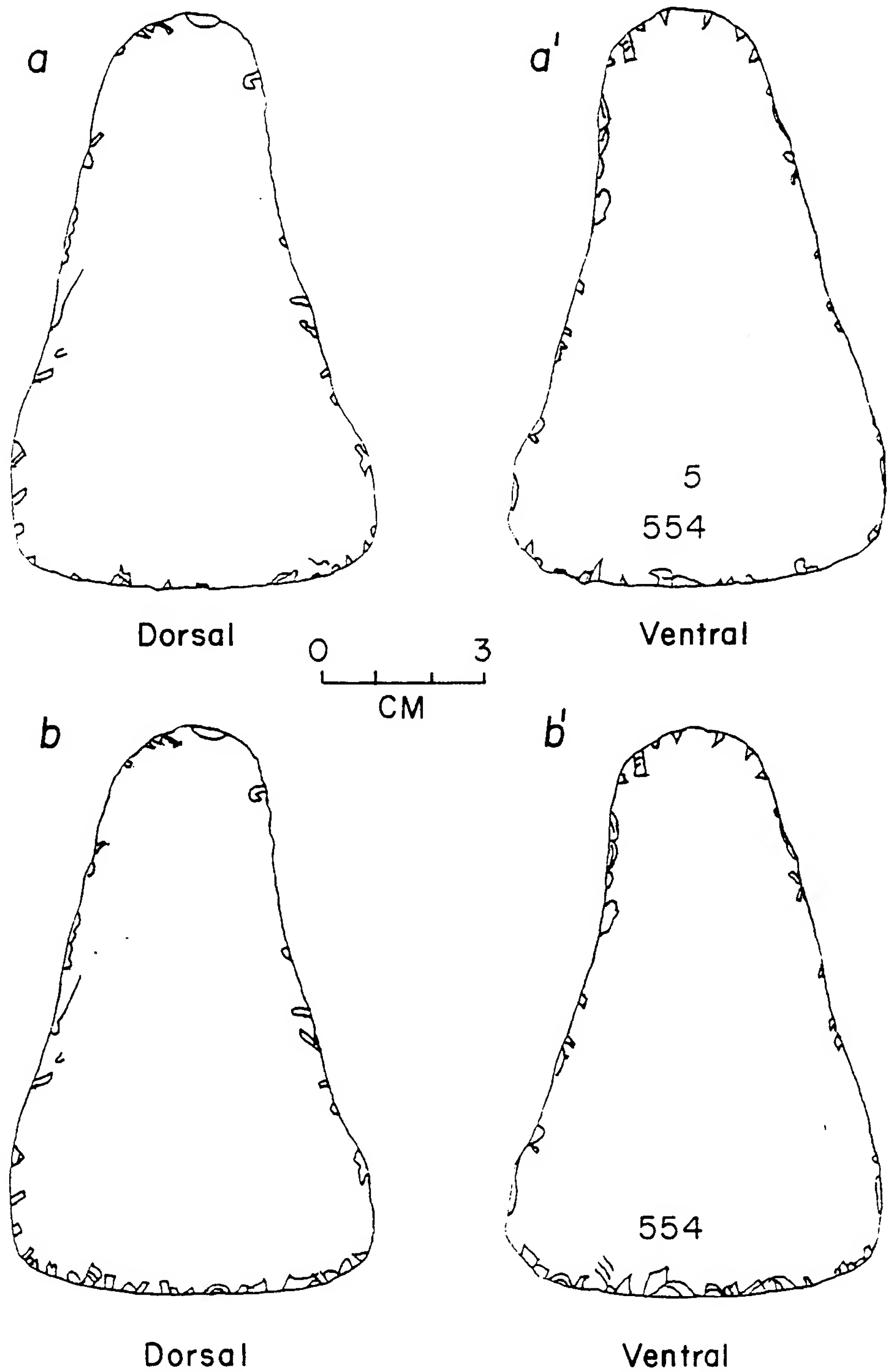

Figure 14. Record of macrowear damage on a hoe used to chop through sod - a, a' before use; b, b' after use.

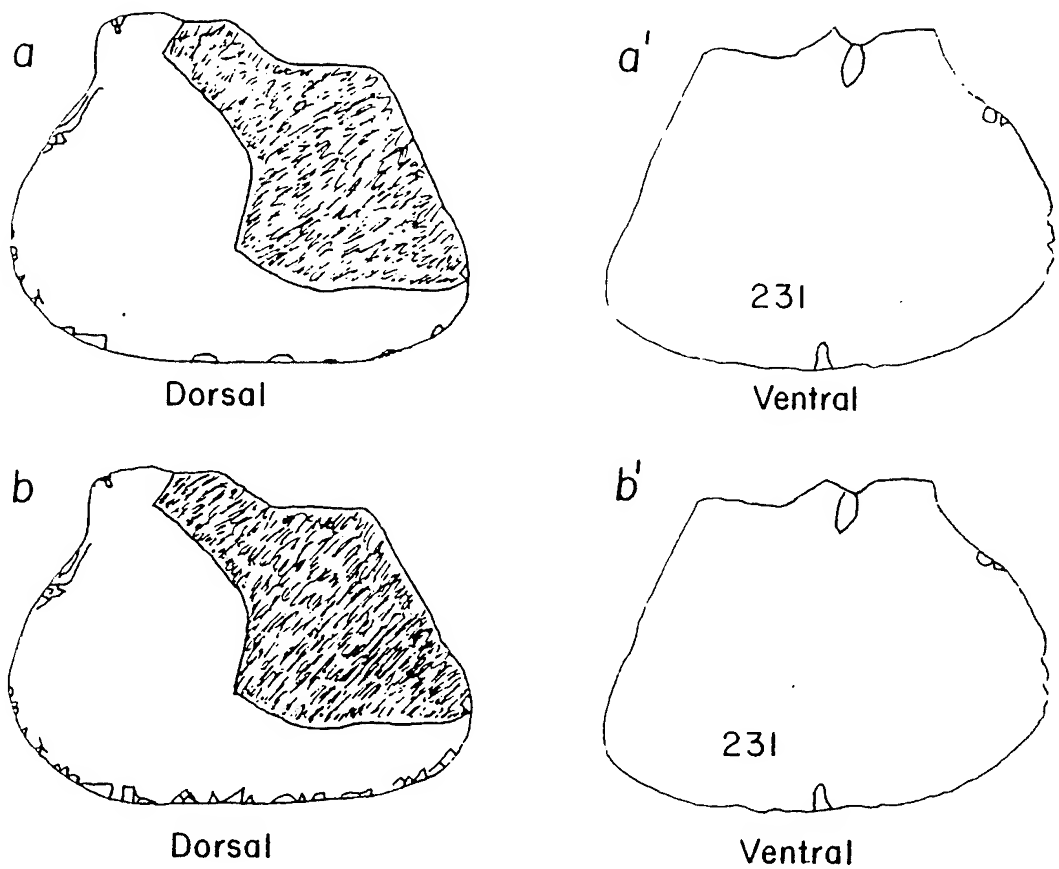

Figure 15. Record of macrowear damage on a scraper used as a hoe - a, a' before use; b, b' after use.

when use-wear is observed on the retouched dorsal face of tool 229 (Jefferson City, scraper). It is as concentrated and complex as that observed on tool 554. Use-wear was also observed on the ventral surface of tool 554. Use-wear was also observed on the ventral surface of tool 229 (Fig. 16b'). However, it is much less extensive, and the scars are all individual identifiable geometric forms. Microscopically, retouch seems to have a lesser but still identifiable impact. Crushing and crushing with debris are the most common microscopic use-wear forms observed on retouched tools, the same as they are for all tools in the first experimental series. There is no difference in the frequency of polish development on retouched tools vis-a-vis unretouched or minimally retouched tools. However, the distribution and extent of polish development do tend to differ. On retouched area, polish tends to form only on the projecting portions of the retouch scars. Polish is seldom well developed probably because attrition is occurring simultaneously in the same areas thereby disrupting the stability of the surface necessary for polish development and retention. For tools used for the longitudinal actions of sawing and cutting, polish forms in linear configurations along the extreme edge but not on either face of a heavily retouched tool. Similarly, striations tend to form only along the extreme edge or across the extreme tip of tools used to bore or grave.

Discussion of the Impact of Incidental Damage On Observed Use-Wear Traces

There are two distinct facets of the impact of incidental damage on the isolation and interpretation of use-wear traces. These are: (1) its tendency to be mistaken for use wear and (2) its influence on the formation of use-wear traces. Incidental damage, as used here, refers to damage occurring during manufacture and to unintentional human and non-human modification after manufacture.

The literature on use-wear analysis contains one isolated warning that incidental damage forms scars and distributional patterns which can be mistaken for not only use-wear but also for intentional retouch (Knudson 1979). The clearest example of this in this experimental series is the flake in Figure 6. This tool was not utilized for any purpose. The scars on its margins occurred during manufacture and were observed before pre-use processing began. The small scalar scars alternating from dorsal to ventral to dorsal are consistent with those considered by Tringham et al. (1974: 188-189) to be diagnostic of cutting soft materials. This phenomenon was also encountered in assessing the tools from the blind test experimental series. These instances will be discussed more fully in that section.

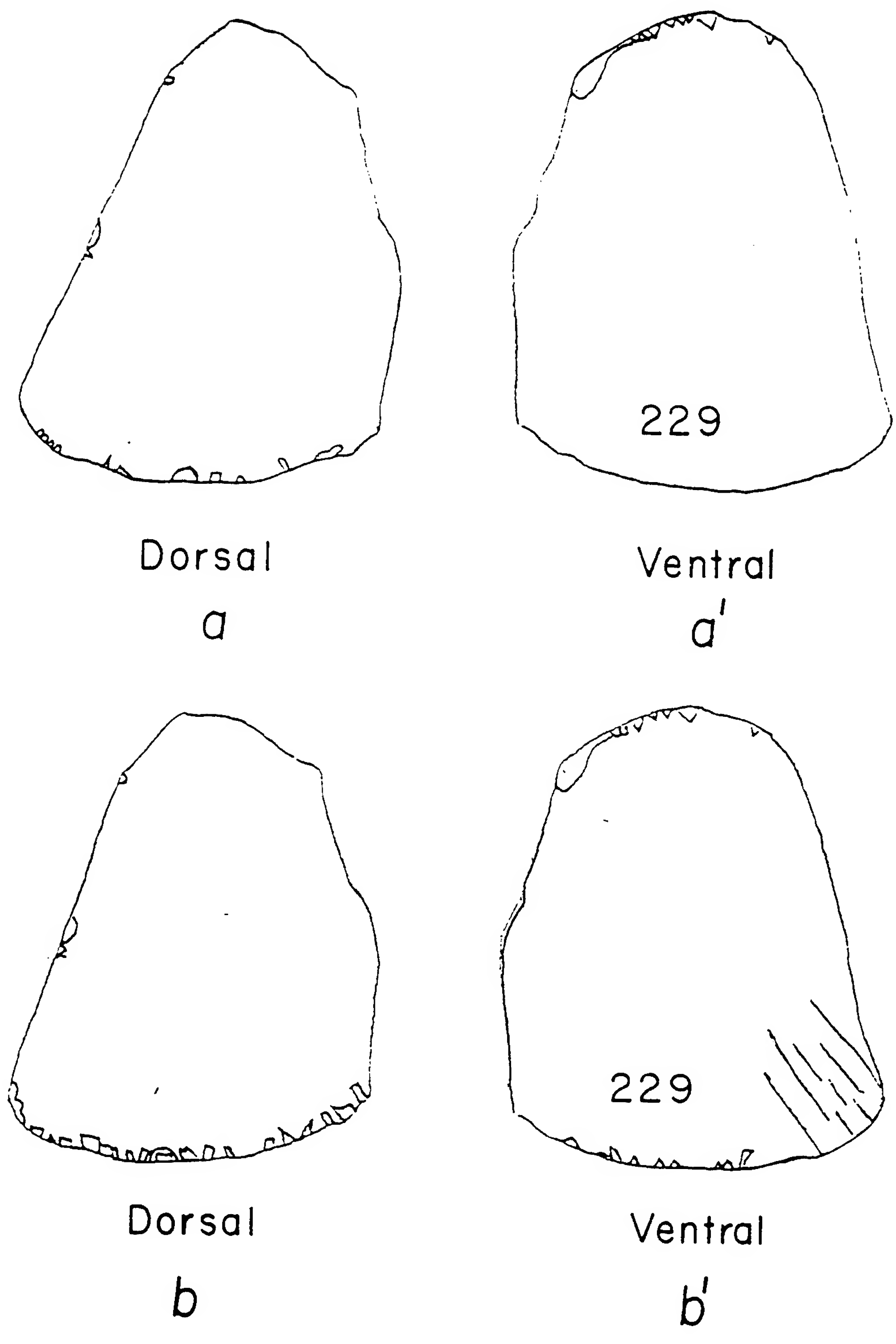

Figure 16. Record of macrowear damage on a scraper used as a hoe - a, a' before use; b, b' after use. Diagonal lines on b' are striations.

It is also true that some patterns of incidental damage resulting from manufacture are similar in size and extent to known use-wear. Figure 16b' shows a use-wear configuration which does not differ significantly from the incidental damage shown in Figure 16a. The use-wear on the distal end of tool 229 (Fig. 16b') is less extensive than the manufacturing damage shown on the proximal end of the same tool (Figs. 16a' and 16b'). If tool 229 were an archeological artifact, the manufacturing damage on its proximal end is like that defined in the literature for transverse cutting (Table 1) and similar in extent and distribution to the known use-wear observed on tool 231 (Figs. 15b and 15b').

There are also indications that some polishes may be a form of incidental damage. This will be discussed more fully in the succeeding section.

The second facet of incidental damage is its effect on the formation of use-wear damage. A comparison of Figures 4a and 5b' and 7a and 16b' indicates that areas having pre-existing incidental damage also have the most extensive and complex use-wear damage. Figures 15a-15b' are the clearest examples. In this way, incidental damage has an effect similar to that described for intentional retouch.

DISCUSSION OF "PAPER BAG" POLISH

As an auxiliary to the blind test experiment, two tools were tested to ascertain the possible effect of storing archeological artifacts in standard brown paper bags, as has long been the practice among archeologists. This experiment was suggested by indications in the literature that plant polish at least is the product of a chemical reaction between the tool and the material being worked. Paper bags are wood pulp products and thus have a similar chemical make-up to that for wood. Additionally, the transport and storage of artifacts both from the field and within the lab in paper bags create a sustained abrasive contact situation among the tools and the bags. In addition to the incidental damage incurred by contact between tools, it was hypothesized that polish development could occur.

Accordingly, two tools were selected from the blind test tool kit by C. Stiles-Hanson, one of the people responsible for utilizing that series without this author's knowledge. One tool, tool 262 (Jefferson City, flake), was rubbed with a brown paper bag from the supply available for the storage of Truman artifacts. The pressure applied was forceful and sustained and lasted for 10 minutes.

The second tool, tool 254 (Jefferson City, flake) was placed in a brown paper bag, the top of which was then folded shut in the same way that the Truman artifact bags

were generally closed. Tool 254 was the only one in the bag. No attempt was made to artificially create tool-bag contact. The tool in the bag was carried down three short flights of steps and placed on a desk in another office. It remained there, except for minor rearrangements of materials on the desk, until it was carried up two short flights of stairs to be placed on a desk in a third office. Total transportation time was not recorded, but probably accounted for no more than five minutes in total. Tool 254 remained in the closed paper bag for three months with only the movement described above.

Both of these experiments were conducted without this author's knowledge. Because they had no counterpart in the first experimental series, this author was informed of the experimental procedures and the contact materials prior to evaluating the tools. The details of the experiments were unknown until after the wear traces had been observed. The results of that evaluation are as follows.

An area of bright, well developed polish was observed on the dorsal surface of tool 262 (Plate 4d).* The polish is very similar in appearance to that observed on tool 234 (Jefferson City, scraper) which was used to saw fresh hard wood (Plate 4c). The similarities in polishes indicate that in abrasive situations, paper bags have the polish producing properties of wood.

A fine film of bright but minimally developed polish was observed over the entire surface of tool 254 (the tool housed in the bag for three months). The polish was clear enough in some areas to identify it as the same polish observed on tool 262 (the tool rubbed with the paper bag). Because tool 254 was subject to only five minutes of abrasive wear over a three month period and because other Jefferson City tools used to process wood for short periods either developed no polish (tool 204, 6 minutes) or developed very slight, poor polish (tool 224, 15 minutes), the source of the polish observed on tool 254 is highly unlikely to be the result of abrasion. The only other explanation is a chemical reaction between the bag and the chert.

These experiments are only a first approximation; they suggest but do not prove that wood polish is in whole or in part the result of a chemical reaction. Because it has important implications both for the applicability of use-wear analysis as a tool for describing the artifacts from

*The photomicrograph of this polish is not as clear as the polish seen through the microscope oculars. The chert is highly oolitic with a relatively transparent surface overlaying the oolites. It presents resolution problems for photography.

the Truman Reservoir area and for other artifact collections handled and stored in the same manner, additional research is definitely needed on this question.

It has been standard practice to store the Truman artifacts in brown paper bags. In such bags, the artifacts have been transported hundreds of miles between the field, the laboratory, and the storage facilities at Sinclair Farm. All of the artifacts reposed in paper bags for at least three months and some as long as five years.

Additionally, this author, while working in the lithics laboratory prior to the inception of the research resulting in this paper, noticed a substantially high number of tools on which a bright gloss was observed over the entire surface of the tools; this gloss was easily visible to the unaided eye. When selected tools of this type were observed microscopically, these high gloss surfaces did not display any of the polish characteristics described in the literature. While the phenomenon was not systematically studied for this paper, it was noted to be particularly prevalent on the artifacts from 23BE676, one of the earlier excavated sites.

The results of the bag-wear experiments and the observations of high gloss polish, which does not have the micropolish characteristics described in the literature or observed in the experimental series presented here, mitigate heavily against the applicability of use-wear analysis, at least that involving observation of polishes, to the Truman artifact collections.

RESULTS OF THE "BLIND TEST" EXPERIMENT

The results of the "blind test" experiment are presented in detail in Table 5. These results are no more encouraging in assessing the applicability of use-wear analysis to the Truman artifact collections than are the results of the first experimental series.

A total of 43 tools were used in a variety of ways on a variety of materials without this author's knowledge. On four of those tools, two separate areas on the tool perimeter were used for separate and distinct tasks. Each of these areas is treated as a tool for purposes of evaluating the correctness of this author's assessment of the blind test tool kit. This raises the number of "tools" in the blind test series to 47.

As noted above and in previous sections, the blind test experiments were conducted without this author's knowledge. The volunteers who actually conducted the experiments were requested to use the first experimental series as a guide in formulating their experiments. They were not,

TABLE 5

Results of Blind Test

Artifact No.	Shape Class	Hypothesized Use: Area	Hypothesized Use: Action	Hypothesized Use: Relative Hardness	Hypothesized Use: Material (Polish)	Actual Use: Area	Actual Use: Action	Actual Use: Relative Hardness	Actual Use: Material (Polish)	Score: A	Score: Act	Score: H	Score: M
228	Scraper	Proximal half right lateral edge	Transverse cutting	Soft	Plant (Tuber)	Not used				-	-	-	-
229	Scraper	Distal edge	Hoeing	Medium (soft & hard	Soil with some plant	Distal and proximal edges	Hoeing	Medium (soft and hard)	Soil, moss, gravel	+ -	+ -	+ -	+ -
230	Scraper	Right half distal edge	Transverse cutting	Hard	Bone	Not used				-	-	-	-
231	Scraper	Distal edge	Transverse cutting	Hard	Wood	Distal edge	Hoeing	Medium (soft and hard)	Grass, moss, dirt, gravel	+	-	X	-
232	Scraper	Distal edge	Transverse cutting	Hard	Bone	Not used				-	-	-	-
233	Scraper	Left lateral edge dorsal facing	Sawing	Soft	Unknown (no polish)	Not used				-	-	-	NA
234	Scraper	Right lateral side dorsal facing	Sawing	Hard	Wood	Right lateral side dorsal facing	Sawing	Hard	Wood	+	+	+	+
235	Adze	Distal end	Hoeing	Medium (soft & hard)	Soil and plant	Distal end	Hoeing	Medium (soft and hard)	Soil, leaves roots, gravel	+	+	+	+
236	Cleaver	Distal end	Unknown	Unknown	Unknown (no polish)	Distal end	Chopping	Hard	Wood	+	-	-	NA
236A	Drill	Not used				Not used				+	NA	NA	NA
237	Drill	Distal end (drill tip)	Boring	Hard	Bone	Distal End (drill tip)	Boring	Hard	Bone	+	+	+	+
238	Drill	Distal end (drill tip)	Boring	Hard	Unknown (no polish)	Distal end (drill tip)	Boring	Hard and medium	Wood, tanned leather strap	+	+	+	NA
239	Axe	Distal end	Sawing	Soft	Meat	Distal end	Cutting, sawing, chopping	Soft and hard	Hair, meat, bone	+	X	X	X
240	Biface	Distal half left lateral edge dorsal facing	Sawing	Soft	Unknown (no polish)	Distal half left lateral edge dorsal facing	Sawing	Soft	Meat and connective tissue	+	+	+	NA

TABLE 5: Continued

Results of Blind Test

Artifact No.	Shape Class	Hypothesized Use: Area	Hypothesized Use: Action	Hypothesized Use: Relative Hardness	Hypothesized Use: Material (Polish)	Actual Use: Area	Actual Use: Action	Actual Use: Relative Hardness	Actual Use: Material (Polish)	Score: A	Score: Act	Score: H	Score: M
241	Biface	Proximal third left lateral edge dorsal facing	Sawing	Hard	Bone	Proximal third left lateral edge dorsal facing	Cutting	Hard	Bone	+	-	+	+
242	Biface	Proximal third right lateral edge dorsal facing	Saw	Hard	Wood	Not used				-	-	-	-
243	Biface	Proximal half left lateral side dorsal facing	Sawing	Hard	Bone	Proximal half both lateral sides	Hoeing	Medium and hard	Potting soil and sand	+	-	X	-
										-	-	-	-
244	Biface	Proximal half left lateral edge dorsal facing	Cutting	Soft	Meat	Proximal half left lateral edge dorsal facing	Sawing	Soft	Plant	+	-	+	-
245	Spokeshave	Concave area left lateral side dorsal facing	Transverse cutting	Hard	Wood	Concave area left lateral side dorsal facing	Transverse cutting	Hard	Wood	+	+	+	+
246	Spokeshave	Concave area right lateral side dorsal facing	Transverse cutting	Hard	Wood	Concave area right lateral side dorsal facing	Transverse cutting	Hard	Wood	+	+	+	+
247	Spokeshave	Concave area distal end	Transverse cutting	Hard	Unknown (no polish)	Not used				-	-	-	NA
248	Denticulate	Distal half left lateral edge dorsal facing	Sawing	Hard	Wood	Distal half left lateral edge dorsal facing	Sawing	Hard soft	Bone, meat hair *used 3 times bone dominant	+	+	X	-
249	Denticulate	Proximal and medial areas of right lateral side dorsal facing	Sawing	Medium	Plant	Proximal and medial areas of right lateral side	Transverse cutting sawing	Hard	Wood	+	X	-	-
250	Graver	Left lateral edge dorsal facing	Cutting	Soft	Meat	Left lateral edge dorsal facing	Cutting	Medium	Tanned leather	+	+	-	-
251	Graver	Projection on left lateral edge dorsal facing	Graving	Hard	Bone	Projection on left lateral edge dorsal facing	Graving	Hard	Bone	+	+	+	+
252	Graver	Projection on right lateral edge dorsal facing	Graving	Hard	Bone	Not used				-	-	-	-

TABLE 5: Continued

Results of Blind Test

Artifact No.	Shape Class	HYPOTHESIZED USE Area	Action	Relative Hardness	Material (Polish)	ACTUAL USE Area	Action	Relative Hardness	Material (Polish)	SCORE A	Act	H	M
253	Graver	Distal end	Transverse cutting	Soft	Plant	Not used				-	-	-	-
255	Flake	Proximal and medial sections left lateral edge dorsal facing	Cutting	Soft	Meat	Proximal and medial sections left lateral edge dorsal facing	Cutting	Soft some hard	Meat, connective tissue, hide, hair	+	+	+	+
256	Flake	Medial and distal sections left lateral edge dorsal facing	Cutting	Soft hard	Mean bone	Not used				-	-	-	-
257	Flake	Right lateral edge dorsal facing	Sawing	Hard	Bone	Right lateral edge dorsal facing	Sawing	Soft hard	Potato and wooden cutting board	+	+	X	-
		Concave area medial section left lateral edge dorsal facing	Transverse cutting	Hard	Bone	Concave area medial section left lateral edge dorsal facing	Sawing and forcing straight down when tool became wedged in material	Soft hard	Potato and wooden cutting board	+	+	X	-
258	Flake	Proximal third left lateral edge dorsal facing	Sawing	Soft	Unknonw (no polish)	Not used				-	-	-	NA
259	Flake	Medial section right lateral edge dorsal facing	Cutting	Soft	Meat	Medial section right lateral edge dorsal facing	Transverse cutting	Hard (soaked in water)	Antler	X	X	X	-
260	Flake	Medial and distal sections right lateral edge dorsal facing	Cutting	Soft	Meat	Medial and distal sections right lateral edge dorsal facing	Cutting	Medium	Tanned hide	+	+	-	-
261	Flake	Distal half right lateral side dorsal facing	Cutting sawing	Soft hard	Meat bone	Distal half right lateral side dorsal facing	Cutting	Soft hard	Meat, hide, connective tissue hair	+	X	+	X
263	Flake	Distal half right lateral side dorsal facing	Cutting	Soft	Meat	Not used				-	-	-	-
264	Flake	Not used				Not used				+	NA	NA	NA

TABLE 5: Continued

Results of Blind Test

Artifact No.	Shape Class	Hypothesized Use: Area	Hypothesized Use: Action	Hypothesized Use: Relative Hardness	Hypothesized Use: Material (Polish)	Actual Use: Area	Actual Use: Action	Actual Use: Relative Hardness	Actual Use: Material (Polish)	Score: A	Score: Act	Score: H	Score: M
265	Flake	Not used				Distal end	Hoeing	Medium (hard and soft)	Potting soil, sand	-	-	-	-
266	Flake	Distal half right lateral side dorsal facing	Sawing	Hard	Unknown (no polish)	Distal half right lateral side dorsal facing	Sawing, cutting	Hard	Wood	+	X	+	NA
267	Flake	Medial third right lateral side dorsal facing	Transverse cutting	Hard	Antler	Medial third right lateral side dorsal facing	Sawing	Hard	Antler	+	-	+	+
						Left lateral side	Sawing	Hard	Antler	-	-	-	-
268	Flake	Not used				Not used				+	NA	NA	NA
269	Cobble/ Hammerstone	Distal end*	Pounding	Hard soft	Stone plant	Distal end*	Pounding	Hard** soft	Stone** wheat germ	+	+	+	+
270	Flake	Not used				Distal half right lateral edge dorsal facing	Cutting	Soft	Plant	-	-	-	-
289	Biface	Proximal third right lateral edge dorsal facing	Sawing	Hard	Antler	Proximal third right lateral edge dorsal facing	Transverse cutting	Soft hard	Tendons bone	+	-	X	-

*This tool is a river cobble; battered area arbitrarily designated distal.
**Tool used as hammerstone for flint knapping prior to inclusion in blind test tool kit; this was correctly identified but technically not part of the test.

however, restricted to those combinations of actions and materials; consequently, some tasks are represented in the blind test series which have no counterparts in the first experimental series. The volunteers were requested not to allow the shape class of the tools and the implied functions normally associated with those shape classes to unduly influence the way in which the tools were used. The only restriction placed on the use of the blind test tool kit was that only actions and materials likely to have been performed or used aboriginally should be included in the experiments.

The blind test tool kit was observed and recorded both before and after use in the same manner as the first experimental series. These observations and records were also made without this author's knowledge.

After use, each tool was examined both macroscopically and microscopically by this author, and both levels of use-wear traces were used in evaluating the tools. Separate identifications of the area utilized, the mode of action, the relative hardness of the material worked and the generic material itself were made for each tool.

Each of those identifications was scored for correctness and is presented in Table 5. In that section of the table, a plus (+) indicates a correct identification and a minus (-) indicates an incorrect identification. An ex (x) indicates a partially correct identification; it is used when only one of multiple actions or materials was correctly identified. In one instance, an underlined ex (x̲) was used to indicate a basically incorrect identification which is mitigated to some extent by circumstances which will be described in detail later in this section. Not applicable, abbreviated N/A, is used to indicate identifications for which there is no evidence on which to base a determination. It is used in instances where no polish was observed and for modes of action, relative hardnesses of materials and materials processed for tools which were correctly identified as not utilized.

Overall Results

Of the forty-seven tools, fourteen or 30% of the blind test series tools were correctly assessed for all four areas, e.g., area utilized, mode of action, relative hardness of material, and generic material. These tools include both retouched and unretouched examples; they are, however, predominantly retouched. These included three unused tools; tools used for chopping, sawing, cutting, transverse cutting, boring, graving and pounding; tools used to process soft, medium and hard materials; and tools used to process soil, wood, bone, meat, and plants. These correct identifications speak for themselves and will not be discussed further here.

Sixteen or 34% of the tools from the blind test experimental series were incorrectly assessed for all four categories. These included three of the four tools on which two separate areas were utilized. In this instances, the second utilized area was over looked. This is attributable to carelessness and to a predisposition to consider a tool to have only one working edge.

Eleven of the incorrectly identified tools were assessed as utilized when they were in fact unutilized. These tools have important implications in determining the applicability of use-wear analysis in describing the Truman artifact collections. For each of these tools, sufficient "use-wear" evidence was observed in order to justify the assessments given. These will be discussed in detail in the following subsection.

Two tools were incorrectly identified as unutilized when they, in fact, had been used. No definitely use related damage was observed on tool 270. According to the experimental notes, the tool had been used for approximately two minutes to slice a philadendron stalk. This was a soft material which left no evidence after a task of short duration. The use-wear evidence observed on tool 265 was ambiguous. All edges of the tool were acute, uncrushed, and unfractured. However, two areas of polish were observed. The polish was attributed to production related handling, and the tool was assessed as unused. Tool 265 was actually used to dig in potting soil for 15 minutes. This activity left no use-wear damage. According to the experimenter's notes, the polish observed was indeed from handling, although that handling occurred during utilization and not production.

The remaining seventeen tools or 36% of the blind-test experimental series tools were correctly assessed in one or more categories and incorrectly assessed in others. Like the incorrectly assessed tools, these seventeen have an important bearing on the validity of use-wear as a descriptive device in the context of the Truman Reservoir collections and will be discussed in detail below.

"Use-Wear" Evidence on Unused Tools

As stated above "use-wear" evidence, like that observed for tools of known use in the first experimental series, was observed on eleven unutilized tools in the blind test series. These tools graphically illustrate the impact and breadth of incidental damage on the interpretation of use-wear evidence where the task related history of the tools is unknown. The "use-wear" evidence and its counterparts in the first experimental series will be presented individually for each of these tools. Regardless of the evidence, all are unutilized.

Finger prints and slight nibbling of the working edge were observed on tool 228, a scraper. Tool 228 was assessed as having been used for transverse cutting on soft plant material. This interpretation is consistent with the evidence observed in the first experimental series for tools 846, 848, 856 and 274; all were used to cut soft plant materials.

For tool 230, a scraper, limited areas of polish were observed on the ventral surface. Finger prints were identified toward the proximal end. On the basis of these observations, tool 230 was interpreted as having been used to transversely cut hard bone. This is consistent with the use-wear observed for tools 731, 533 and 208 in the first experimental series; all were used to whittle bone.

Tool 232, a scraper, was assessed as having been used to transversely cut hard bone on the basis of minor polish and crushing observed on the dorsal face and a continuous band of polish near the edge on the ventral surface. This evidence is consistent with the use-wear observed on the tools from the first series listed for tool 230.

Nibbling and snap scars were observed along the working edge of tool 233, and fingerprints were identified in appropriate areas. No polish was observed. Tool 233 was interpreted as having been used to saw a soft, unidentified material. Its "use-wear" patterns were consistent with those observed on tools 241, 846, 565, and 228 in the first series and with the model for that action presented in Table 1.

Tool 242 was interpreted as being used for sawing hard wood on the basis of the crushing and scarring observed on its "working edge" and on the appropriate placement of a finger print. These were the same use-wear patterns observed for tools 809, 401, and 113 in the first series. All three tools were used for sawing seasoned oak.

Heavy crushing in the retouched area on tool 247 caused it to be interpreted as a tool used to transversely cut a hard unknown material. This was consistent with the crushing observed on tools 731, 533, 208 (whittle bone), 139 (plane antler), 730, 572, 141, 409 and 293 (plane wood), even though polish was also observed on some but not all of these tools.

A massively crushed projection caused tool 252 to be assessed as a tool used to grave hard bone. This pattern is consistent with those observed on tools 815, 516, 205 and 206; all were used to grave bone in the first experimental series.

Slight retouch or similar incidental damage on the edge of tool 253 caused it to be interpreted as a tool used to transcut soft plant material. This interpretation is consistent with the macroscopic use-wear damage observed on grass cutting tools 504 and 565.

Light polish and striations consistent with cutting actions (ventral) coupled with more well developed polish and a single large complex scar (dorsal) justified the interpretation of tool 256 as a tool used to cut soft meat and hard bone. The use-wear damage observed for multi-material tools 230, 127, 523, 151 and 277 supports this interpretation.

Slight nibbling on the edge of tool 258 led to the hypothesis that it was used for a short time to cut some soft unknown material. This interpretation is consistent with the use-wear observed on tool 155 used to cut meat in the first experimental series. The damage observed on tool 258 is a clearer indication of use for a short period on a soft material than that observed for blind test tool 270 which was used in that manner.

Ill-defined polish, finger prints and meat residue on the edge of tool 263 led to its interpretation as a tool used to cut soft meat. Although the meat residue is the determining factor in the interpretation, the remaining use-wear observed, in itself, is consistent with that observed for tool 290 in the first experimental series.

Partially Correct Identifications

In the same manner as that described for the eleven incorrectly identified tools discussed above, the partially correct identifications for the following seventeen tools act to identify and graphically illustrate the limitations of use-wear analysis. These tools speak to the ability of the use related evidence to reveal the actual modes of action, relative hardness and generic material utilized.

The question here is not whether utilization can be identified; each area utilized was correctly designated. Instead, it is whether the evidence of use can provide enough additional detail to enable an investigator to place the tools in a more detailed descriptive context such as that promised by the literature. The results of this phase of the blind test series suggest the capabilities of use-wear analysis are far more restricted, at least with these tools and materials, than had been expected.

Tool 231 was interpreted as a tool used for transversely cutting on hard wood. This interpretation was based on large stepped scalar scars localized on the ventral surface of its distal end and on very bright polish observed all along the

working edge. The polish was like that shown in Plates 2e and 4c. The scar types and distributions were consistent with hard materials.

Tool 231 was actually used for chopping or hoeing medium density soil. As noted above and shown in Plate 4b and Plate 4c, wood and plant polishes are virtually synonomous. Soil has been classed as a medium density material because it contains both hard and soft components. In this instance, the hard gravel inclusions produced the scarring patterns observed. Additionally, the distribution of scars only on one face is not indicative of transverse cutting in this instance.

The cleaver numbered 236 is probably the most interesting tool in either tool kit used in these experiments. It was assessed as a tool utilized for an unknown action on an unknown material. The sole evidence for use was minor crushing with white powdery debris on one of the micro-projections. Because crushing with debris had been observed only for utilized tools, utilization was definite. However, there was no additional evidence upon which to base assessments of mode of action, relative hardness of material or generic material.

A check of the experimenter's notes indicated that this tool had been used for approximately 30 minutes to chop a branch. This was a high impact activity resulting in continual flaking and fracturing of the edge. Like the adzes from the first experimental series, what appears to be intentional retouch is actually massive use-wear scarring. It is impossible to differentiate the two.

Tool 239, an axe, was interpreted as having been used to cut soft meat with a sawing action. This interpretation was based on minor crushing of the edge and a dull greasy polish on both faces along the working edge. Tool 239 was actually used on three different occasions to dismember portions of the deer. Cutting, sawing, and chopping motions were used, and the tool came in contact with hair, meat, and bone. The use-wear evidence preserved only a portion of this multiple action and material process. The assessment is correct but incomplete. This suggests that use-wear does not always record multiple actions and materials.

Tool 241 was assessed as having been used to saw hard bone. This assessment is correct in all respects except that the actual action was cutting and not sawing. The difficulty in differentiating these two actions is consistent with the results of the first experimental series.

Use-wear traces observed on tool 243 consisted of heavy crushing and some ill defined polish on the working edge and fingerprints. On this basis tool 243 was interpreted as

having been used to saw hard bone. The tool had actually been used to dig in a mixture of potting soil and sand. Only the hard component of the soil mixture was preserved and recognized. The position of the hand was correct.

Tool 244 was assessed as having been used to cut soft meat. It was, however, used to saw soft plant material. As noted above both in this section and in the results of the first experimental series, cutting and sawing can rarely be distinguished. In addition, use time was short, approximately five minutes, and yielded minimal polish development which was incorrectly identified.

Tool 248 was thought to have been used to saw hard wood. It was actually used for sawing actions on three different occasions. The collective contact materials were hair, meat, and bone, with bone being the dominant contact material. In this instance, unlike 239 above, the use-wear traces preserved the hardest of the multiple materials processed. The polish observed on this tool was bright and well developed. This is inconsistent with the bone polish described for the first experimental series. While the exact source of this polish is unknown, it may have resulted from the interaction of all three materials processed or from whatever unknown agency produced the polishes observed on the eleven unused tools described above.

Tool 249 was interpreted as a tool used to reap (cut) grass (plant). It was actually used to cut and saw hard wood. Here the second action overrode the first. The retouch on the teeth of this denticulate may have acted to obscure larger scarring indicative of hard materials. This is not the only possible explanation. The results of the first experimental series indicate that hard materials do sometimes produce small stepped scars believed to be indicative of medium density materials. The polish on tool 249 was very bright and fluid. While this is normally the result of processing plants, it can also be produced by wood (Plates 2e and 4c).

Tool 250 was correctly identified as having been used to cut a soft material. However, that material was incorrectly identified as meat rather than tanned leather. The polishes produced by these materials can be quite similar (Plates 3a and 3c).

Both lateral edges of tool 257 were interpreted as being used to process hard bone. The right edge was correctly identified as being used for sawing and the left correctly as used for a transverse action. Both edges were used, however, to slice potatoes on a wooden cutting board. In this instance only evidence of the hard wood was preserved on the tools. Polish produced by potatoes does not

rise to the level of that defined for grass or modified for Jerusalem artichokes in the first experimental series. This suggests that it would be improper to expect all plant materials to produce the classic plant polish.

Tool 259, a flake, was interpreted as being used to cut soft meat. It was actually used for a transverse action, a specialized form of cutting. The results of the first experimental series do indicate that transverse cutting can produce distributions of use-wear damage similar to those derived from cutting.

Tool 259 was actually used to process hard antler. The errors in evaluation are not, however, as preposterous as they seem at first glance. The antler used had been soaked in water. The use time was very short, and the tool was in contact only with the soft hydrated outer layers. The results of the first experimental series indicate that this layer produces soft material use-wear damage. Thus while the evaluation is incorrect for antler generally, it is correct for this isolated instance. As seen in Plates 3b and 3c, antler and meat polishes can, in some instances, be very similar.

Tool 260 was correctly identified as having been used to cut a soft material. However, that material was incorrectly identified as meat rather than tanned hide. These two polishes can be virtually indistinguishable (Plates 3a and 3c).

Tool 261 was identified as having been used to cut and saw soft meat and hard bone. It was one of the few instances in which a tool retained evidence of use on both hard and soft materials. It was, however, used only for cutting. While meat was one of the contact materials, bone was not. Another unidentified hard material, hair, was responsible for that type of damage. The meat polish was correctly identified, however, the additional polish resembling that for bone could not have been produced by that material. The tool was used only for skinning. The source of the polish is unknown; it could be an atypical meat polish, a result of the combined materials or the product of the hair.

Tool 266 was correctly identified as being used to saw a hard unknown material. Again, the cutting action also used was obscured by the sawing use-wear or resulted in a sawing pattern as cited in the results of the first experimental series.

Tool 267 was correctly assessed as having been used to process hard antler. However, the sawing action actually used was incorrectly identified as transverse cutting. The length of the working edge was restricted by the curvature

of the flake; its size was not inconsistent with the area potentially involved with transverse cutting. In addition, the damage was more concentrated on the dorsal face, an observation also consistent with the model for transverse cutting.

The similarities between the damage produced by sawing and transverse cutting are confirmed by tool 289 where transverse cutting was incorrectly identified as a sawing action. Also for tool 289, only use-wear damage indicative of a hard material was preserved on a tool used to scrape and cut tendons from bone. This is understandable since bone was the dominant material processed. The polish produced by this process was mistaken for antler polish. It is probable, but not known, that the presence of the tendons could have produced a more pervasive polish than that known for bone. Additionally, the literature as presented in Table 1 and the results of the first experimental series indicate that bone and rough antler polishes are distinguished mainly by microscopic pot lids which lie beyond the magnification range of the equipment used here.

SUMMARY AND CONCLUSIONS

The results of the first and second experimental series presented above suggest that use-wear analysis is not an effective descriptive device for the Truman Reservoir artifact collections.

The three chert types which are the basic raw materials for the Truman collections are of lesser quality than the flint used to define the use-wear traits presented in the literature. They do not replicate the same constellations of traits defined there. Nor do they form any different but internally consistent constellation of traits which can be used to build a model specific to the Truman collections.

Of the four categories of information which use-wear analysis is believed to clarify or reveal, the area utilized remains the one most likely to be correctly identified. However, even these identifications are suspect in light of the eleven unused tools from the blind test series which were interpreted as utilized on the basis of concrete use-wear indicators of incidental origin.

The results of the first experimental series and the confirming results of the blind test series indicate that longitudinal cutting and sawing actions cannot be differentiated and that occasionally this is also true for cutting, sawing, and transverse cutting actions. Similarly, graving, piercing, and boring actions cannot be differentiated from each other and that because the dominant use-wear form for these and all other tools is crushing or crushing with

debris, correct identifications of these actions are based more on the tool form than on any other indicator. As the blind test series shows, such assumptions can be erroneous. There are no unique use-wear patterns for chopping and pounding actions. The same patterns and characteristics can and do result from incidental damage including manufacturing and from other actions such as transverse cutting. Only eight or 7% of the 107 tools in the first experimental series had distributions of use-wear damage consistent with particular actions as defined in Table 1.

Multiple actions are rarely identifiable. Also, there is no consistency regarding which action, e.g., sawing versus cutting or chopping versus cutting or sawing, is more likely to be preserved.

The scar types and sizes believed to be indicative of a relative degree of material density and hardness do not consistently occur when using tools replicating the Truman collections. Large stepped scars occur with soft materials and small scalar scars occur with hard materials. Some materials, based on the results of the first experimental series, should be classified as hard rather than medium, and hydrated antler which should be soft and not hard. In instances where mixed density materials such as soil with rock and plant inclusions are encountered, there is no way to predict whether the hard or soft material will produce the use-wear damage later observed. The same holds true for butchering tasks encountering bone, meat, hide, hair and connective tissues.

The polishes observed in these experimental series are severely restricted by the strength of the available equipment. That restriction would also hold for any archeological observations which might be made.

The polishes observed in the first and second experimental series tend to resemble each other and to be easily mistaken for one another. Polishes from antler, fresh and dry hide and meat are virtually interchangeable in some instances. The same is true for polishes from soil, wood, and grasses. Dry antler and bone polishes are indistinguishable here because the levels of magnification necessary to reveal microscopic pitting cannot be reached. Although no shell polish was tested in the blind test series, the results from the first experimental series indicate that shell polish is as bright and fluid as classic plant polish derived from processing grasses.

Polishes derived from multi-material contact situations do not produce consistent results. In some instances, one or another of the materials produces the polish. It is not always the dominant material receiving the majority of the

contact that determines the polish. In rare instances, two distinct polishes can be identified. More often the multiple materials interact to produce a new polish which does not duplicate any of the defined polishes (see discussion of tool 289 in the blind test series). These polishes often resemble defined polishes for radically diverse materials.

The results of the first experimental series indicate that the presence of pre-existing incidental damage strongly affects the kinds and distributions of scarring observed, sometimes to the extent of producing patterns alien to the action performed. This is true whether the incidental damage is derived from intentional retouch, other manufacturing processes or miscellaneous non-use related manipulation. Incidental damage can also imitate use-wear patterns believed to be diagnostic of particular actions such as cutting.

On retouched tools, incidental damage is virtually impossible to distinguish from use related damage. Fifty-six percent of the retouched tools in the first experimental series had no identifiable use-wear damage because of the presence of incidental damage.

Incidental damage is not restricted to macroscopic scarring. Polish observed on nine unused tools from the blind test tool kit. A possible explanation exists for seven of these. The seven were either bifacially or unifacially retouched. The flint knapper used a leather pad to protect his hand while knapping. Friction between this pad and the tool during manufacture could have produced some of the polishes. Additionally, an antler tine punch was used for some of the finer retouch; some of the polish could also be derived from this source.

However, these agencies cannot explain the presence of both ill and well defined polish on the remaining two flakes. Paper bag polish is not an option; these tools were always stored in plastic artifact bags. This raises the possibility that plastic bags can also impart an incidental polish. This possibility, however, was not tested in this study.

Tool form has a definite impact on the applicability of use-wear analysis as a descriptive device for use with the Truman collections. All of the use-wear indicators defined in the literature were derived from flakes.

Of the seventy-one retouched tools in the first experimental series, only one definitely had a scarring pattern consistent with the model. Ninety-three percent of these tools had either no definitely use related damage, or forms such as crushing and attrition which have no diagnostic

value for either actions or materials. This is of primary importance because the overwhelming majority of tools in the Truman collections are retouched.

Additionally, in four instances, retouched tools sustained use-wear damage of the same size and characteristics as the intentional retouch found on the same tools. It is impossible to differentiate this use-wear when the use of the tool and its pre-use appearance is unknown.

Because of the factors summarized above, the results of the blind test are not encouraging. These results suggest that the use-wear damage observed can, at best, be correctly identified in all respects for only 30% of the tools surveyed. This is less than the 50% expected by chance.

Even the 30% expectation is not a true indicator for the Truman collections. The tools for the two experimental series described in this paper were handled with extreme care. They were never stored or transported in one unprotected group; they were always placed in individual plastic artifact bags. They were never washed with brushes. The Truman archeological collections, like most such collections, were handled very differently.

The Truman collections, from the time the artifacts were collected until they were analyzed and prepared for permanent curation during the final year of the project, were stored together in brown paper bags. They were transported over hundreds of miles and shifted with relative frequency while stored in that manner. This produced substantial amounts of incidental damage including scarring and abrasion in all instances.

The possibility that this incidental damage could be differentiated by the clean unpolished scars is substantially obviated by the paper bag polish described in the preceding section. This polish is the product not only of abrasion but probably also of a chemical reaction stemming from the tool's presence in the paper bag for prolonged periods. All of the Truman artifacts remained in the paper bags for at least the same length of time as the experimental tools and some as long as five years. This circumstance, coupled with the observation of pervasive well developed polish on all surfaces of numerous tools, suggests that a high percentage of these polishes derive from incidental storage related conditions rather than use.

This is not a real or implied criticism of the way these tools were stored. The project began in 1975. At that time, this was a standard archeological procedure and still is in many places. Similarly, use-wear was not contemplated as a descriptive technique for use with these

collections until late 1979. Additionally, a workable body of literature upon which to base such a study was not available until 1977 and later. The reality of bag-wear polish was not known until the spring of 1980. By that time the damage had been done.

There is an additional source of possible damage similar to that of the bag-wear which cannot be controlled by anyone. The majority of the Truman artifacts from buried sites come from soil matrices composed primarily of expanding clays. The alternating expansion and contraction of the clays is capable of moving artifacts and miscellaneous rock and other particles up and down the soil column. This movement should be capable of producing the same stresses that are known to produce retouch, use-wear scarring and tool attrition. It also produces the abrasive contexts that are thought to produce polishes. Additionally, it is possible that the chemical characteristics of the clays, either alone or in conjunction with ground water, are capable of producing chemical reactions yielding polishes. This is known to occur both for plant polish and for the paper bag polish.

For the reasons cited above, this author believes that use-wear analysis is an inappropriate and ineffective device for describing the Truman artifact collections and should not be used for that purpose.

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Plate 1. a, Tool 838, Burlington graver before use. Magnification 50X. Tip straight on. Exhibits macrowear damage category "abrupt break."

b, Tool 531, Chouteau wedge before use. Magnification 50X. Dorsal face; shows macrowear damage category "scalar scar."

c, Tool 523, Chouteau flake before use. Magnification 50X. Linear features are lances, not striations.

d, Tool 523, Chouteau flake after use. Magnification 70X. Shows use-wear damage which formed inside the lances pictured in 1c.

e. Tool 530, Chouteau scraper, unaltered surface of this chert type. Magnification 70X.

f, Tool 530, Chouteau scraper surface after use. Magnification 70X. Shows true striations.

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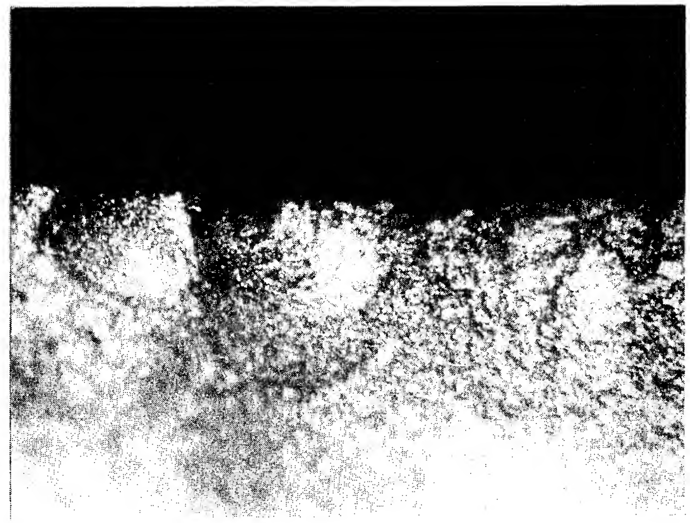

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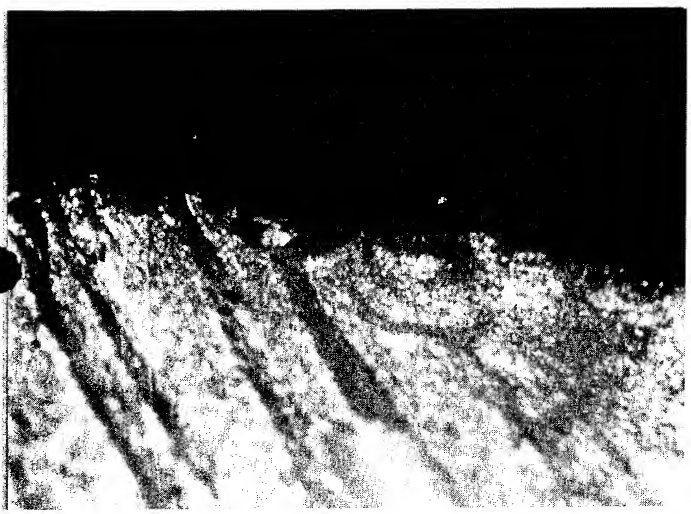

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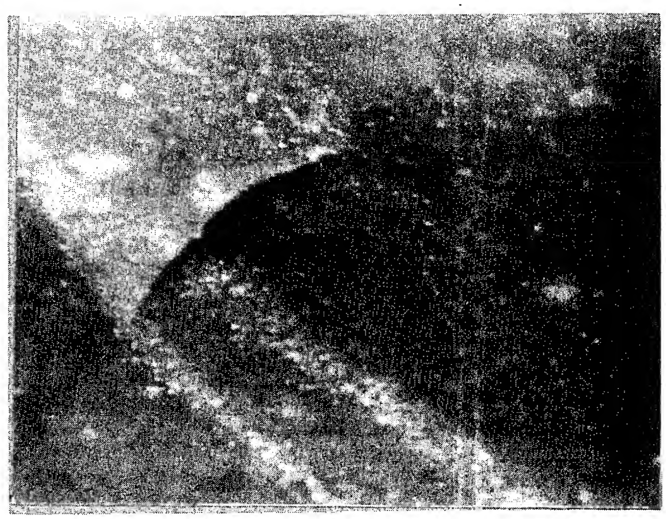

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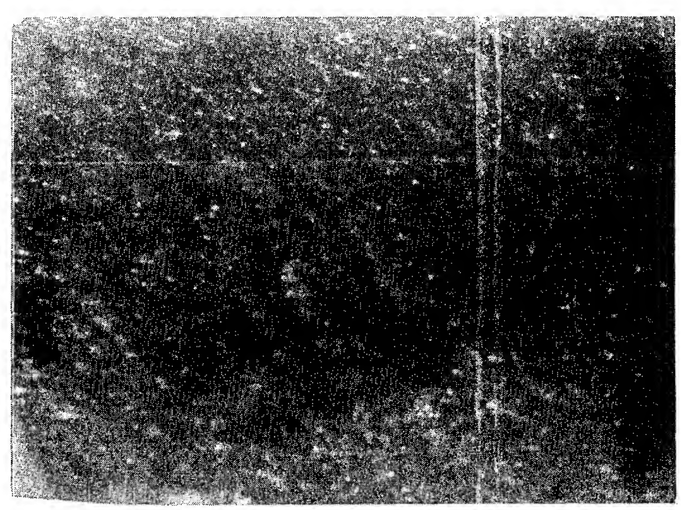

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Plate 2. a, Tool 534, Chouteau biface before use. Magnification 30X. Shows complex fracturing resulting from the manufacturing process.

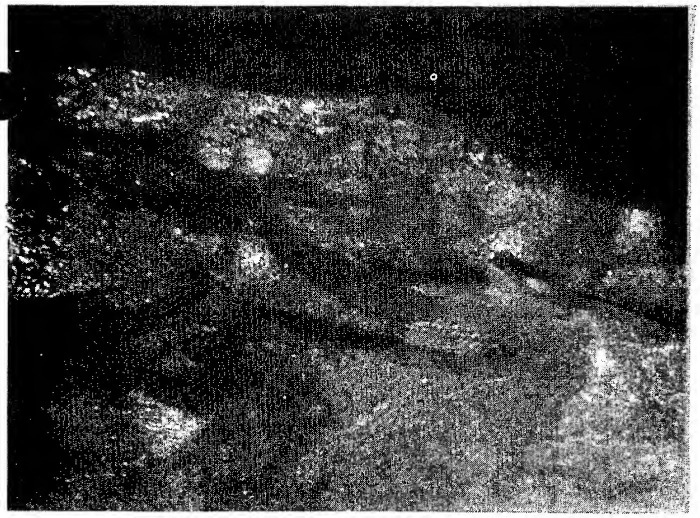
b, Tool 534, Chouteau biface after use. Magnification 50X. Shows crushing of original complex fractures and white powdery debris from the crushing.

c, Tool 544, Chouteau hoe after use. Magnification 70X. Shows crushing without debris and polish associated with chopping soil.

d, Tool 548, Chouteau drill before use. Magnification 70X. Shows the glossy sheen of unaltered Chouteau.

e, Tool 548, Chouteau drill after use. Magnification 40X. Shows polish formed from working wood.

f, Tool 554, Chouteau perforator before use. Magnification 50X. Shows acute margins typical of unused perforators and a Chouteau having a grainier texture than that in the preceding photographs.



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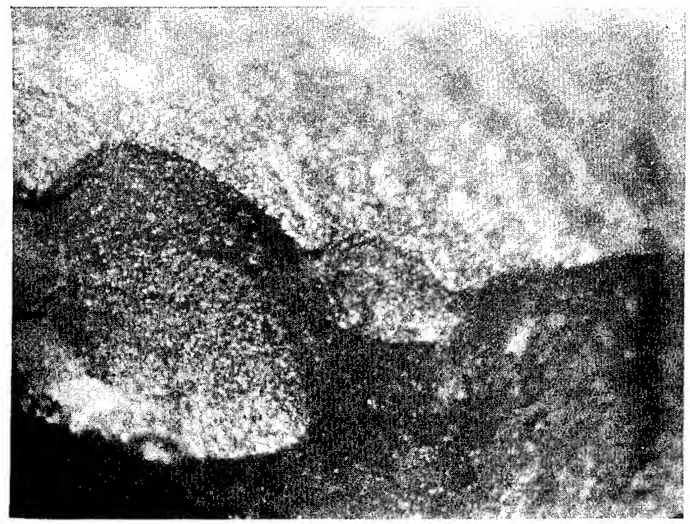

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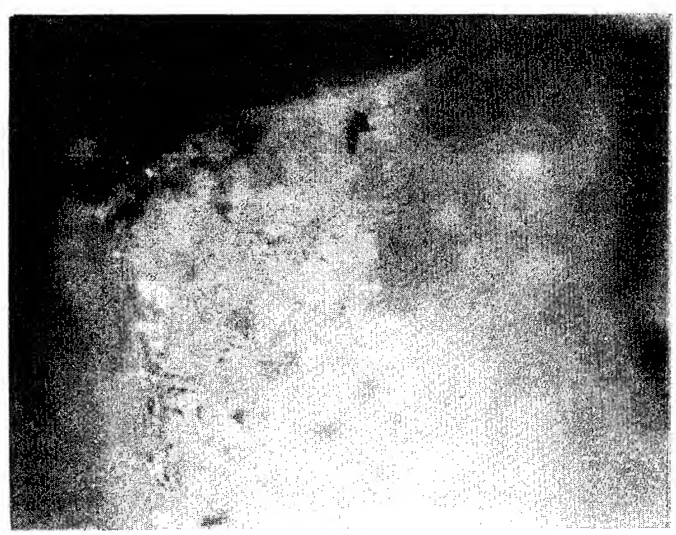

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Plate 3. a, Tool 554, Chouteau perforator after use. Magnification 70X. Shows rough topography of crushed tip and polish formed by working tanned hide.

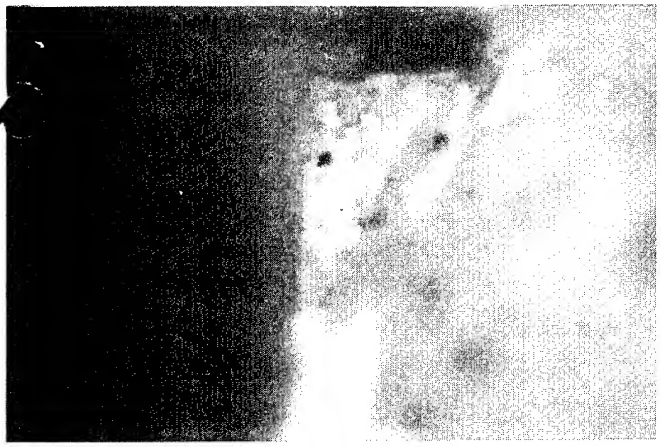
b, Tool 222, Burlington graver after use. Magnification 70X. Shows crushing and complex scarring and polish formed by working antler.

c, Tool 255, Jefferson City flake after use. Magnification 70X. Shows polish formed by cutting meat.

d, Tool 261, Jefferson City flake after use. Magnification 70X. Shows detail of an oval polished area on the surface where the operator's thumb rested during use.

e, Tool 269, River cobble with crystaline interior which was included in the kit for the blind test after having been used as a hammerstone for flint knapping. Shows area battered by that use. Magnification 50X.

f, Tool 269, river cobble hammerstone after being used to crush wheat germ. Mangification 50X. Shows plant polish overlaying previously used area.



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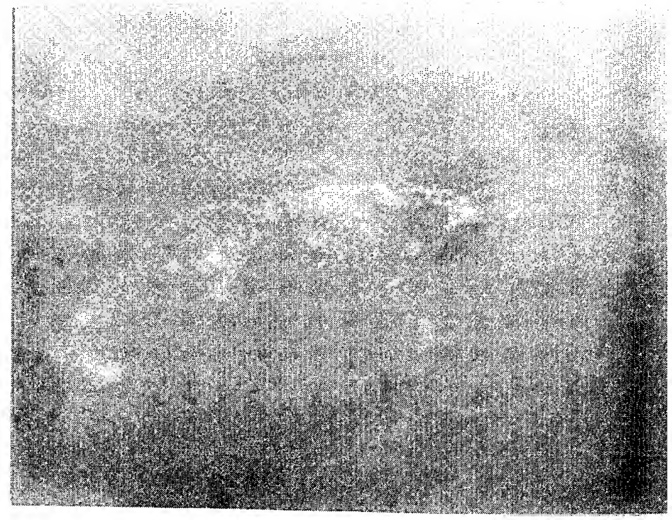

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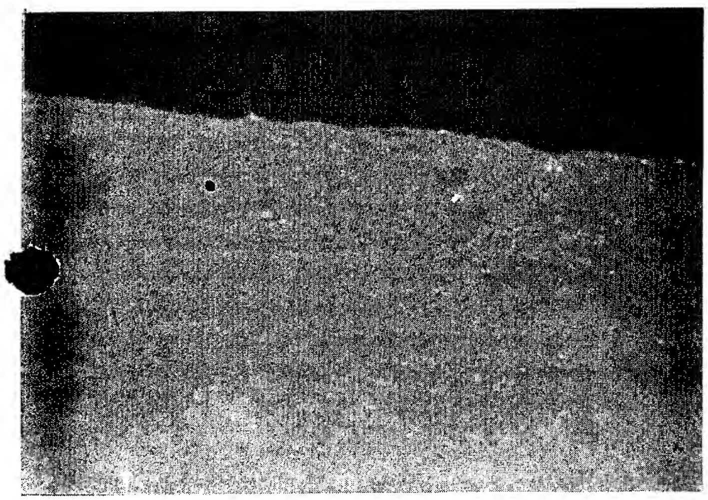

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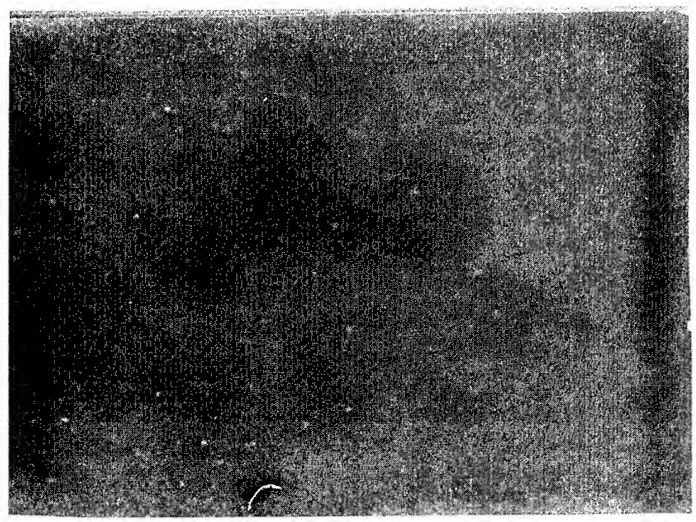

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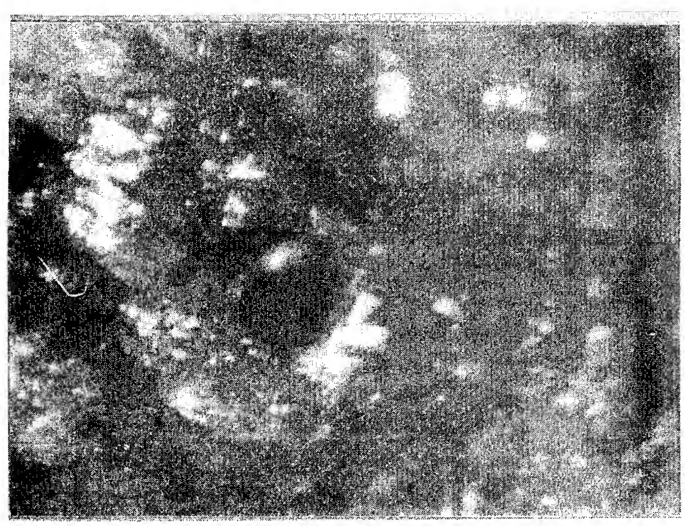

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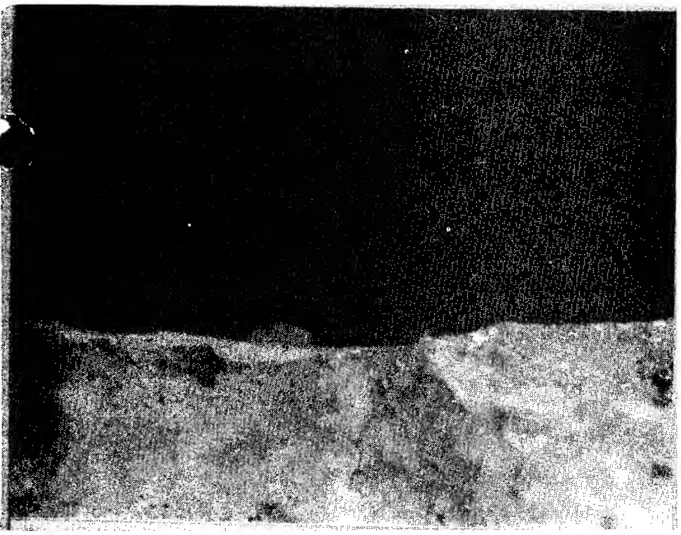
Plate 4. a, Tool 231, Jefferson City scraper before use. Magnification 50X. Shows the texture of unutilized oolitic Jefferson City chert.

b, Tool 231, Jefferson City scraper after use as a hoe. Magnification 40X. Shows bright plant-like polish formed from contact with grass, moss, soil and gravel during use. Also shows the effect of the original chert surface on the resolution of the polish.

c, Tool 234, Jefferson City scraper after being used to saw fresh hard wood. Magnification 70X. Shows bright polish similar to plant polish. It also illustrates the difference in the appearance of the polish on non-oolitic Jefferson City chert.

d, Tool 262, Jefferson City flake after being rubbed with a paper bag. Magnification 70X. Shows the effect of long term storage of stone tools in paper bags. Polish is bright and similar in appearance to the wood polish shown in 4c.

e, Tool 722, Burlington scraper before use. Magnification 50X. Shows a fine line of polish along the edge which is the result of manufacture and or pre-use processing.



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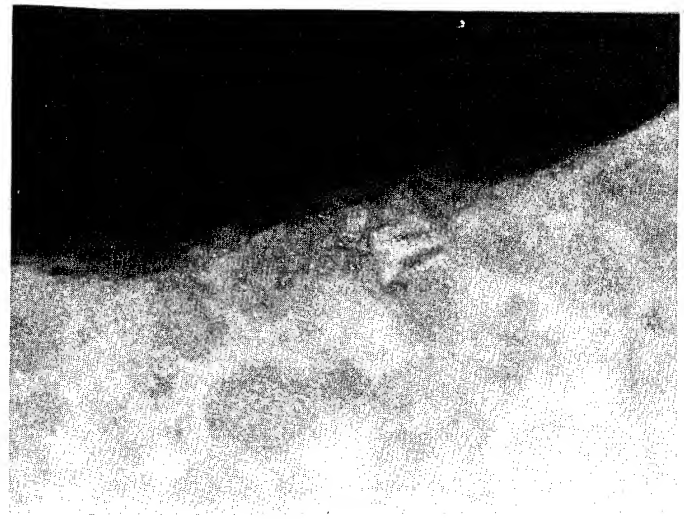

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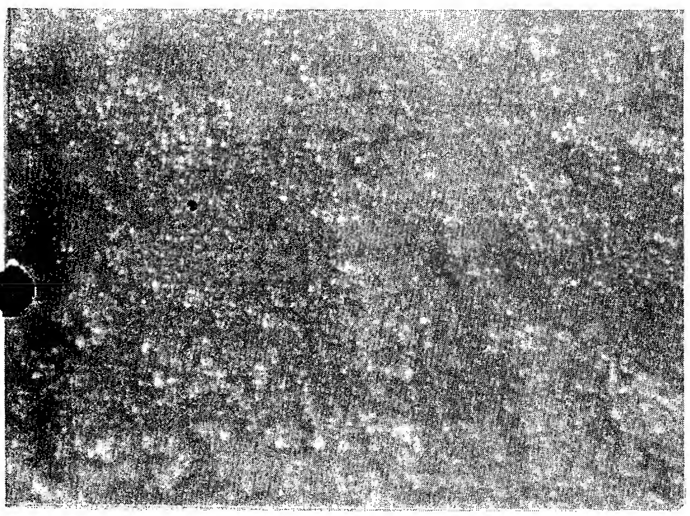

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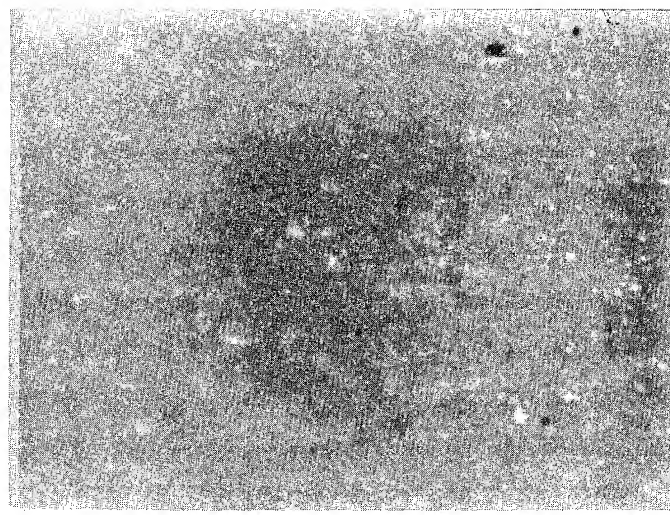

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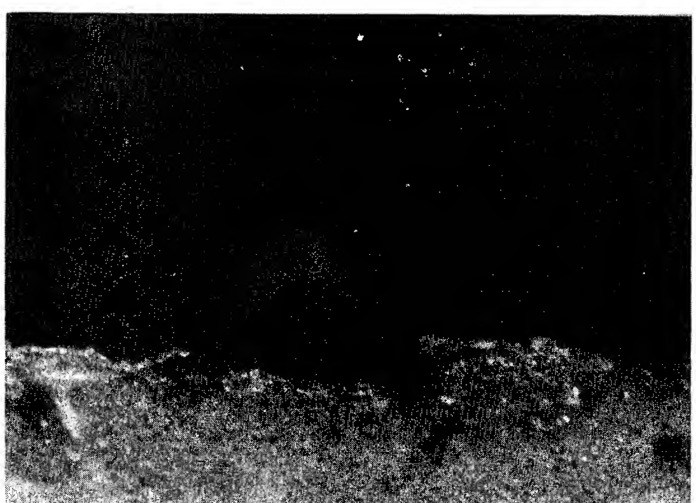

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PART IV.

LITHICS STUDIES

NUMBER 6.

AN ANALYSIS OF EIGHT LATE ARCHAIC PERIOD SITES IN THE TRUMAN PROJECT AREA

by

Diane L. Solov

Acknowledgements

My interest in the topic of this paper is a result of two years of working with the lithic materials from the Harry S. Truman Reservoir Archeology Project. Many thanks can be offered to those who gave me the opportunity to participate so fully in the project's efforts, and who so conscientiously helped me to pursue my own ideas and interests.

Specific acknowledgement must be made to Dr. Donna C. Roper, Project Director, for the opportunity for "hands on" experience, for her support throughout my association with the project, and for the technical skills she afforded me in drafting the figures for this paper.

Objectives

The intent of this paper is to investigate the post-Hypsithermal, pre-ceramic cultures of the western Ozark Highland region in the Harry S. Truman Reservoir project area. Because the only archeological evidence of these populations is the sites of occupation and the stone tools and debris, a description and analysis of surface collected lithic materials in terms of technology and morphology is required to examine the composition and attempt the definition of a Late Archaic assemblage. The following problems will be addressed:

1. a description of Late Archaic lithic artifacts,

2. an examination of the availability and use of chert resources, this to adduce evidence for determining whether the Late Archaic populations represented in the reservoir area are indigenous or may have moved into the region for hunting and gathering, and

3. the comparison of the sample of Late Archaic lithic inventories from the Truman Reservoir area to other Late Archaic components in Missouri.

The Archaic

The Archaic Stage in North American prehistory exhibits a far-ranging distribution with abundant local and regional variants from the desert southwest to the northeast woodlands. The time span of the Archaic varies regionally, occurring from about 8000 B.P. or earlier and reaching into the Historic period in the Plains (Jennings 1968: 127; Fig. 1).

The term Archaic denotes a general subsistence pattern of hunting and foraging, with prolonged site use not found in previous periods, inferred from the presence of formalized burials, accumulated refuse, and red ochre. In addition to these criteria, Willey and Phillips (1958: 104-110) include the presence of ground stone woodworking tools, milling tools, atlatl weights, and stone tubes and beads as artifacts characteristic of the Archaic. Innovations in chipped stone technology in the Archaic are found in the tool forms of the drill, and stemmed, corner-notched, and side-notched projectile point forms. Rough stone items included are hammerstones, anvil stones, abraders, and notched pebbles. Archaic period archeological sites characteristically have evidence

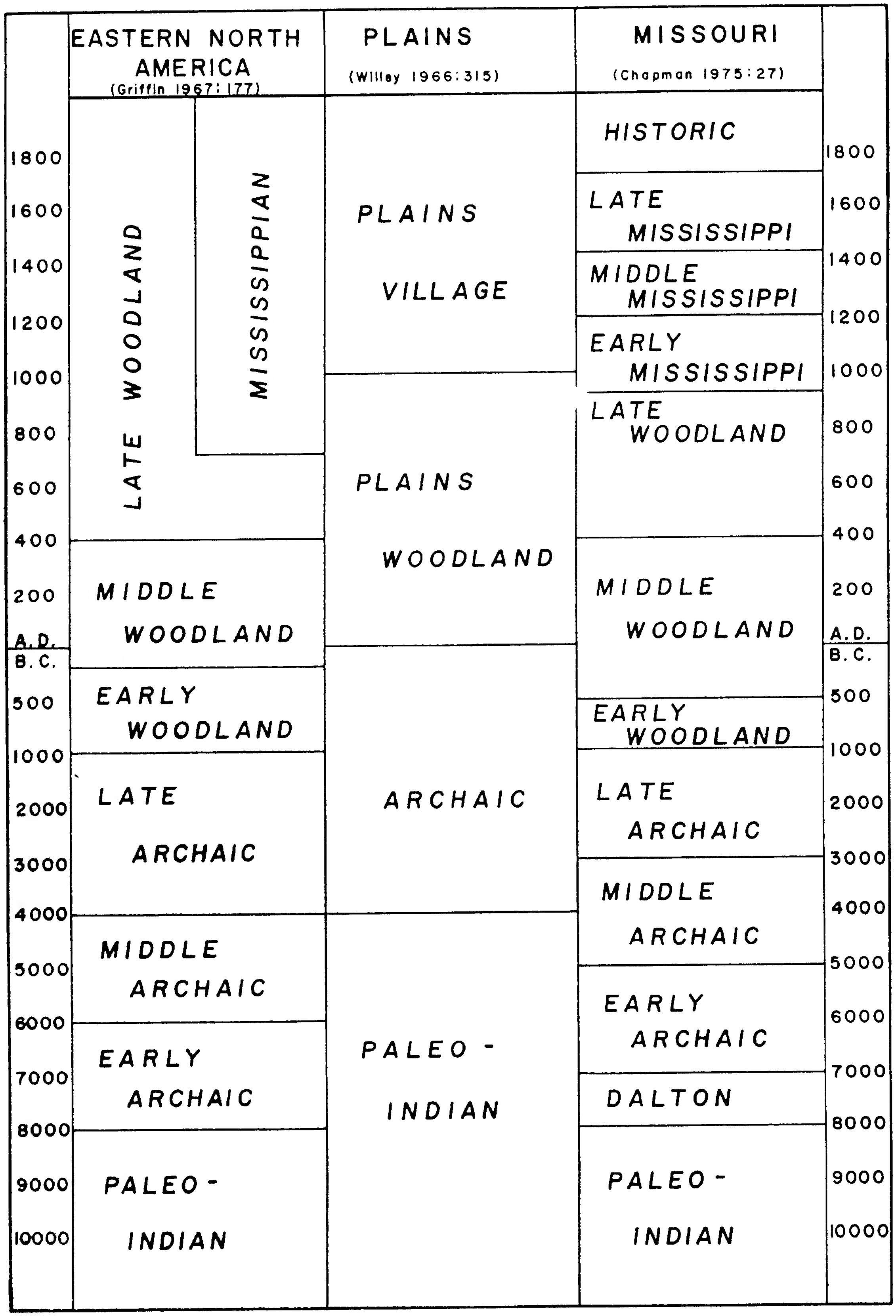

Figure 1. Cultural-temporal periods in Eastern North America, the Plains, and in Missouri (from Roper 1977: 18).

of cooking and stone boiling with the presence of fire-cracked rock, and other specific activity indicators such as bone and ivory awls and needles, and a tool kit for the exploitation of riverine and lacustrine environments (Willey and Phillips 1958: 104-110).

The Archaic in Missouri

The Archaic as represented in Missouri prehistory ranges temporally from about 9000 B.P. to the ceramic cultures of the Woodland period, beginning about 3000 B.P. (Chapman 1975: 27). It is termed the Forager Tradition by Chapman and is subdivided into three cultural-temporal periods: the Early Archaic, the Middle Archaic, and the Late Archaic. Chapman (1975: 127) describes the onset of the Forager Tradition as

> the broad‹ning of subsistence activities to exploit a greater variety of ecological niches in the environment. Hunting and collecting on land during the Archaic period continued as a major economic activity, but more emphasis began to be placed on collecting shellfish and fishing.

Chapman further speculates that the Archaic saw a shift from nomadic hunting to the establishment of base camps in which extended families lived and performed their subsistence activities, exploiting resources within the range of the base camp.

The Late Archaic period in Missouri has been defined temporally as occurring from about 5000 B.P. to about 3000 B.P., coinciding with the conclusion of the Hypsithermal. Regional variants of this period are recognized throughout Missouri. Archeological remains occurring throughout the state thought to be indicative of a Late Archaic occupation include a high incidence of the Sedalia Digger (a functionally distinct tool from the Clear Fork Gouge); milling tools including manos and metates; tool manufacturing tools including hammerstones; a variety of lanceolate-like, stemmed and corner-notched projectile point forms; and an increased use of hematite. An increase in foraging activities is presumed for the Late Archaic as tool morphology and polish remaining on tool forms indicate the use of more tools for plant processing and woodworking (Chapman 1975: 184). Economically, during the Late Archaic "the framework was being laid for a change from foraging to a foraging incipient agricultural economy" (Chapman 1975: 185-186).

Late Archaic culture is represented at the deeply stratified Rodgers Shelter in the western Ozark Highland (Wood and McMillan 1976; Kay 1978). After a hiatus of an estimated 3000 years, a Late Archaic occupation was

represented at Rodgers Shelter and estimated to date between 3000 and 2000 B.P. (dates slightly at variance with Chapman's dates for the Late Archaic). It was concluded that this period saw an increase in diversification of activity. Evidence leading to this conclusion includes the first and only occurrence of burials at the site, a greater variety of projectile points and cutting tools, and a significant number of pitted handstones (McMillan 1976: 226). Late Archaic projectile point forms include: Smith Basal Notched, Table Rock Stemmed, variants of the Sedalia Lanceolate, and Stone Square Stemmed.

Hunting practices shifted in the Late Archaic at Rodgers Shelter from the procurement of smaller game such as terrestrial turtles, rabbits, and rodents in the Middle Archaic to heavy exploitation of deer and lesser use of the aquatic turtles and mussels (McMillan 1976: 220).

The Sedalia complex represents a Late Archaic cultural manifestation of foraging subsistence activities. It has been defined from the collections of several sites near Sedalia in Pettis County in the Northwest Prairie region of Missouri. Characteristic tools include the Clear Fork Gouge, Sedalia Digger, drills, choppers, hammerstones, three-quarter grooved and full-grooved axes, bannerstones, manos, ground hematite, and Sedalia Lanceolate, Stone Square Stemmed, Smith Basal Notched, and Nebo Hill projectile point forms (Chapman 1975: 201-203). Chapman (1975: 227) concludes that an emphasis on foraging is indicated by the high incidence of the Clear Fork Gouge, Sedalia Diggers, and manos which all are tool forms associated with woodworking, and plant procurement and processing.

The Phillips Spring site in the western Ozark Highland region has a Late Archaic component with radiocarbon dates of 3330 B.P. to 2910 B.P. Large amounts of fire cracked rock are present. The lithic material inventory for this component includes varieties of corner-notched, side-notched, straight-stemmed, and concave base projectile points, a hafted scraper, two gouges, numerous bifaces, hammerstones, cores, and manos and metates. Pitted stone and worked hematite were also present (Chomko 1978; Kay 1978).

Late Archaic sites in the Truman Reservoir are numerous and found throughout the reservoir area in more variable microenvironments than previously (Figure 2); although Roper (personal communication) suggests that this may be partly a result of decreased aggradation by the rivers and, consequently, less frequent erosion or burial of Late Archaic sites. The point styles that are thought to be indicative of the Late Archaic throughout the reservoir include Afton, Smith, Etley, Sedalia, and Nebo Hill. Cupp and Table Rock

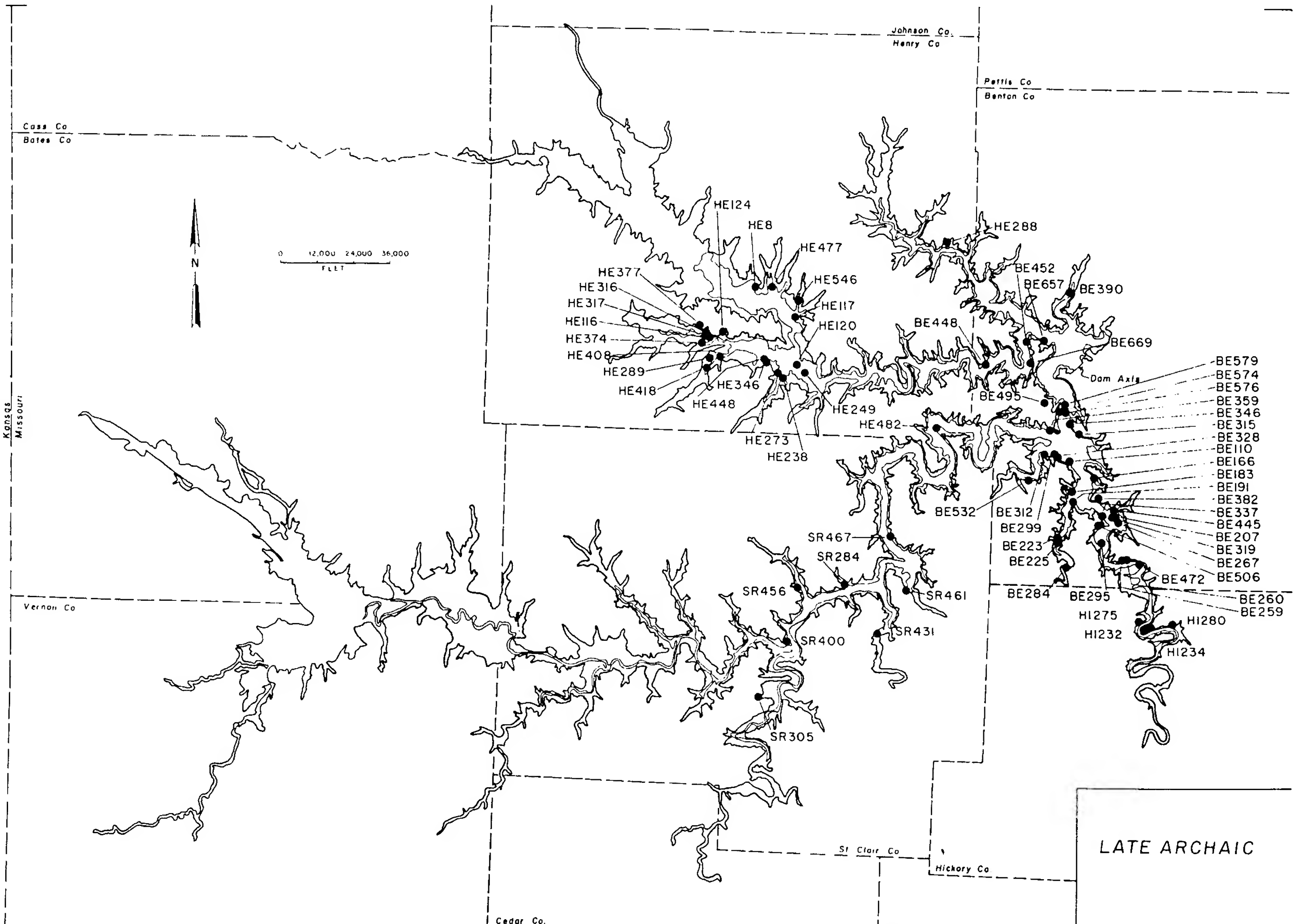

Figure 2. Late Archaic sites in the Truman Reservoir (from Roper 1977).

Stemmed points may also be Late Archaic. Distributions of some of these types show regional variation. Joyer and Roper (1980: 20) demonstrate that the Etley point, associated with the Titterington Focus, is confined to the eastern part of the reservoir area, and that Nebo Hill points, although scarce, are found exclusively in the Western Prairie region, in the northwest part of the reservoir area.

The Environment

The Truman Reservoir project area lies in the Prairie Peninsula on the western border of the Ozarks, in the ecotonal region between the Western Prairie and the Ozark Highland (Fig. 3). The Western Prairie region is characterized by low relief and gently rolling topography, covered by vegetation consisting of tall grasses, with hardwoods in the bottomland stream valleys. The Ozark Highland region is an area with variable relief, with elevations higher than other regions in the state. It is characterized by narrow valleys, with medium sloping hills and flat divides that encourage prairie vegetation. Oak-hickory forests are dominant, but juniper is an invading species in the region (Chapman 1975: 15-17; Roper, personal communication).

Soils of the Western Prairie and Ozark Highland are the Cherokee Prairie soils and Ozark soils, respectively (Fig. 4). Because soils form under the mutual influence of climate, topography, parent material, organisms, and time (Brady 1974: 303), they reflect, to a degree, the nature of the past vegetation. Prairie soils, because of the high amount of organic matter from prairie grasses, are typically dark in color with crumbly-structured surface horizons, thus readily distinguishable from mature forest soils which exhibit grey-brown surface horizons and illuvial clay subsurface horizons (Brady 1974: 326-330).

The climate, as described by a U.S. Department of Agriculture report (1970), features frequent weather changes, receiving cold Canadian air from the north, warm, moist air from the Gulf of Mexico, and dry air from the desert west. Prevailing winds are from the south-southwest. Mean annual precipitation is from 36 to 46 inches, but extremes are not uncommon. Temperatures reach 90 degrees Fahrenheit for several days in the summer and drop below freezing on an average of 100 days per year.

Numerous investigations of spring deposits in the Truman Reservoir area have produced a paleoenvironmental model for the region. The brief summary that follows is taken from King and Lindsay (1976: 76).

Open pine parkland was the dominant vegetation from at least 34,000 to about 24,000 years ago, associated with

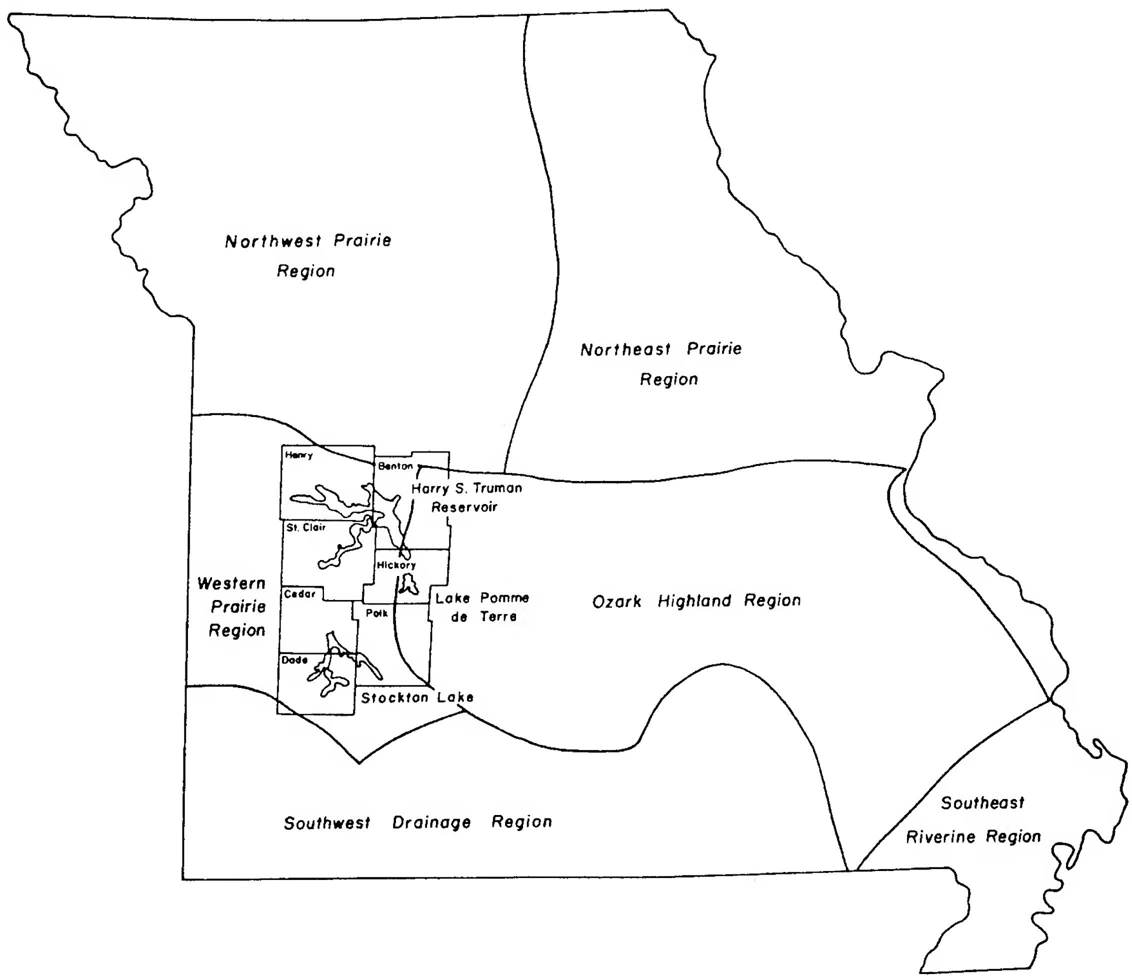

Figure 3. The geographical location of the Truman Reservoir area (after Chapman 1975).

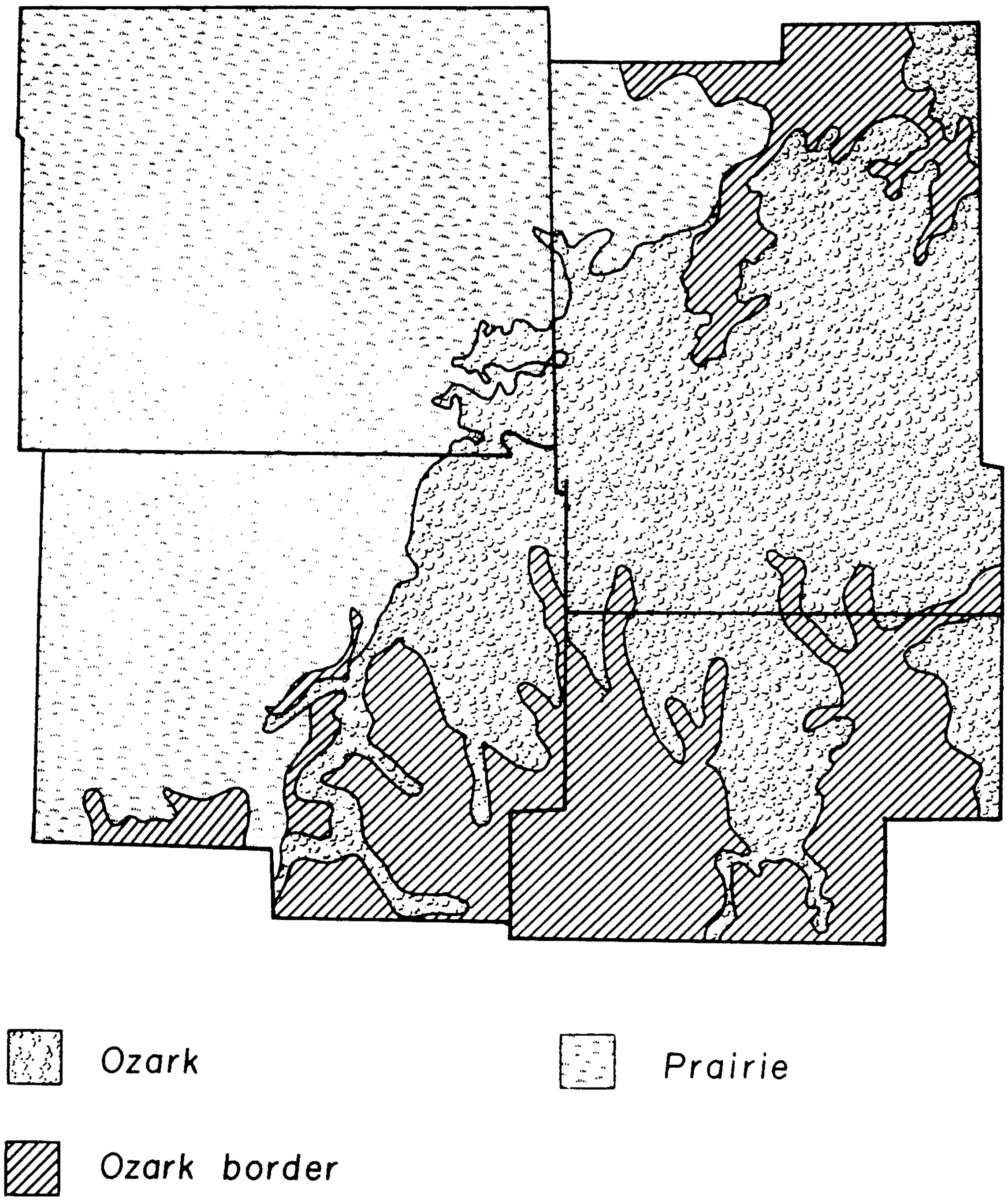

Figure 4. Soil distribution in the Truman Reservoir Project area (from Allgood and Persinger 1979).

the mastodon, horse, and muskox, during the interstade previous to the Late Wisconsinan glaciation. With the onset of the Late Wisconsinan, a shift to spruce forest occurred, it in turn beginning to diminish by about 14,000 B.P. with the encroachment of deciduous trees. Mastodon, tapir, ground sloth, deer, giant beaver and horse were present during this period, becoming extinct about 10,000 B.P. Deciduous oak-hickory forest was established by 12,000 B.P.

Cultural, faunal, and sediment evidence from Rodgers Shelter are interpreted to reflect a gradual shift from a forest-edge environment to prairie during a period of climatic warming and drying beginning as early as 8600 B.P. This trend peaked around 8000-7000 B.P., and lasted for another few thousand years. By 3000 B.P., however, the reestablishment of forest was accomplished (McMillan 1976: 227-228). Thus, the Late Archaic inhabitants of the central Osage Basin would have occupied an environment similar to that before the beginning of Euro-American agriculture.

On the Analysis of Surface Sites

The investigation of a sample of Late Archaic surface sites was undertaken, with the goal of adding to the data base for the interpretation of prehistoric cultural patterns in the Truman Reservoir area. The distribution patterns of cultural components expressed as surface scatters of archeological remains have been addressed in terms of adaptation to the biophysical environment at the intersite level in the Truman Reservoir (Joyer and Roper 1980). From the analysis of surface collections at the intrasite level, the discernment of intensity of occupation, the establishment of temporal association, and an insight into procurement activities are possible.

The value of the analysis of surficial lithic scatters of non-stratified and/or disturbed archeological sites has only recently been recognized with the onset of conservation archeology. Because of existing federal and state legislation, the required assessment of the significance of archeological sites to plan preservation of cultural resources has led to an examination of sites other than those that are completely intact.

As Schiffer and Gumerman point out, ". . . the significance of something can only be interpreted relative to some frame of reference" (Schiffer and Gumerman 1977: 239). Cultural resource management studies have led to general agreement that archeological sites attain significance as their research potential is such that it may provide pertinent information for current research problems (Schiffer and House 1977: 249). The determination of significance

"involves the potential for using a cultural resources to establish reliable facts and generalizations about the past" (Moratto and Kelly 1978: 5). This investigation was pursued with these premises in mind.

Methods

The sample is composed of the artifacts from eight sites, chosen from among 22 surface sites originally identified as single component Late Archaic from the Stage I survey of the Truman Reservoir (Roper 1977). Because this author had no control over the collection strategy of the lithic materials employed by the surveyor(s), the eight sites were chosen on the primary basis of the intensity of collection, with the aim of obtaining aggregates representative of the tools and debris present at the site. Although an attempt was made to sample geographic variability in the reservoir area, most sites in the sample are located on stream terraces (Fig. 5).

The tools and debris from the eight sites examined were described using the definitions, terminology, and coding system established by the Harry S. Truman Reservoir Project Lithics Laboratory of 1978 to 1980 to maintain consistency in data collection with other project materials. Basically, the terminology used does not deviate from traditional usage in the archeological literature. Some explanation is necessary, however, for an understanding of the data presented. (For an explanation more detailed than that offered below, see Volume II of this report.)

The descriptions that follow are based on technological and morphological attributes of the artifacts. Although some tool names imply function, microscopic edge wear analysis was not attempted and terms reflect functional categories only as they are evident morphologically and/or by macroscopically determined edge reduction. The aim of the descriptive system developed by the Lithics Lab focuses primarily on the stages of the lithic reduction sequence and the subsequent morphological manifestation of a tool.

Each artifact was assigned to a REDUCTION STAGE category based on its position in the lithic reduction sequence and to a MORPHOLOGICAL CLASS category based on additional attributes of shape. When the technological class was not determinable or did not assume a form other than that of its technological origin, the same term was coded in both the REDUCTION STAGE and the MORPHOLOGICAL CLASS categories. In some cases the words were spelled or ordered differently for computer retrieval purposes. A morphological name was assigned in the MORPHOLOGICAL CLASS if the form of the artifact was altered from its technological origin.

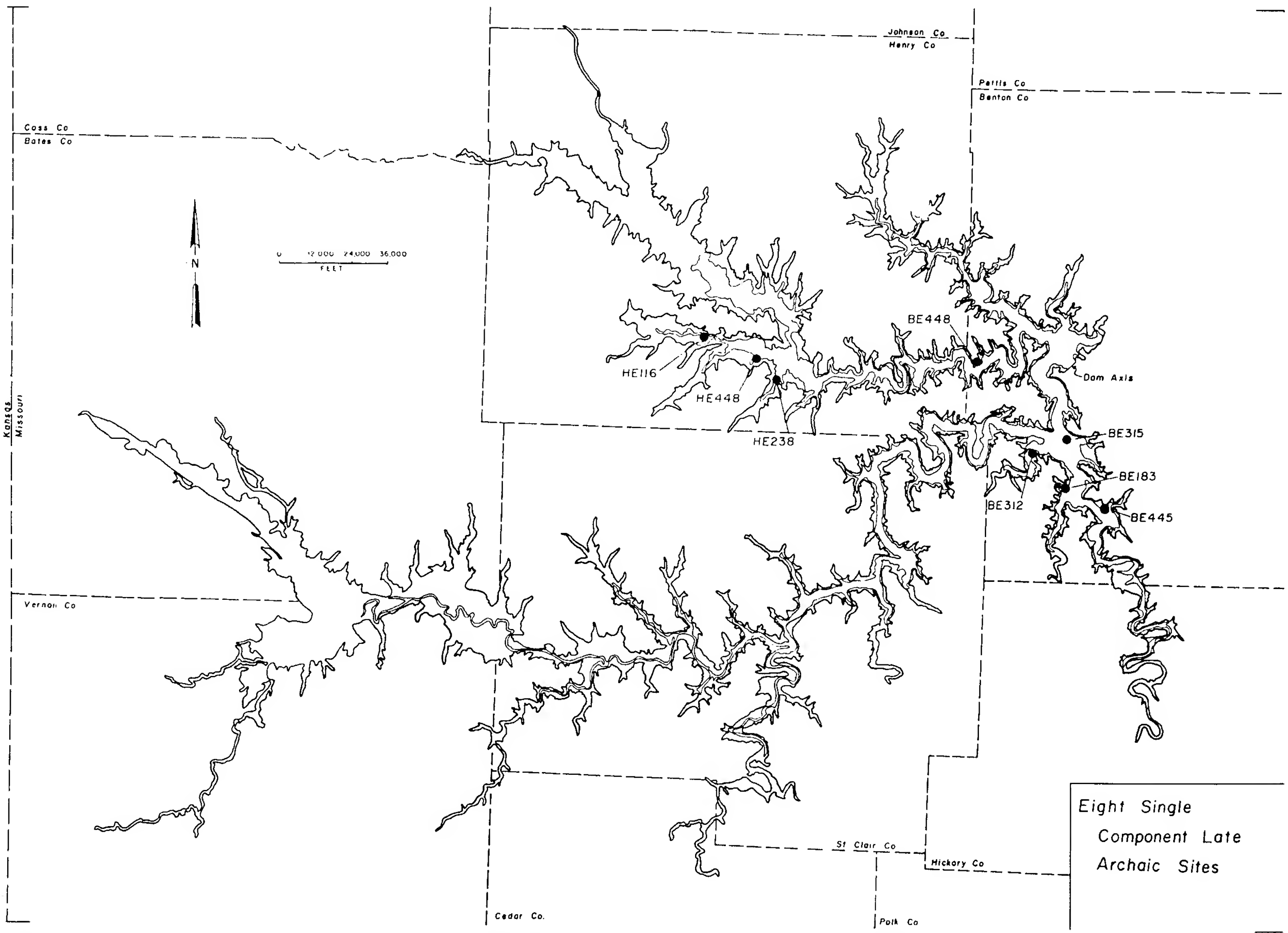

Figure 5. Eight Late Archaic sites in the Truman Reservoir Project area.

In addition to the above classifications, the type of chert (e.g., Burlington, Jefferson City, etc.) and the source of chert (e.g., nodular, secondarily weathered, river cobble, etc.) were determined when possible. Any specimen smaller than 15 mm^2 was considered too small to discern chert type.

CHUNKS are pieces of unmodified chert, distinguished from POTENTIAL RAW MATERIAL, which are chert nodules with one flake scar. SHATTER is defined as an angular piece of chert resulting from the knapping process. Modification is noted if present on shatter and the artifact is therefore coded as UTILIZED or RETOUCHED.

CORES are defined as pieces of chert exhibiting at least two major flake scars resulting from purposeful removal for the reduction of the core or the production of flakes. The level of reduction is coded for cores. A CORTEX CORE is one which retains at least 50% cortex, a RANDOMLY FLAKED CORE is one from which flakes were removed from different faces of the nodule in an apparently random fashion, and a PREPARED PLATFORM CORE is one on which evidence for pre-flaking platform modification is present. Modification by and/or for use of the core is coded as RETOUCHED, UTILIZED, or UNMODIFIED.

Flakes are classed using "flake indicator" criteria. These include the presence of a bulb of percussion and/or ripple marks oriented concentrically from the bulb or bulb remnant. Flakes are further observed as to the REDUCTION LEVEL, that is, whether they are CORTEX, PRIMARY, SECONDARY, or TERTIARY flakes. This is determined by noting the absence of cortex, or if present, the location of the cortex on the flake. A cortex flake retains cortex both on the striking platform and on the entire dorsal surface; a primary flake retains cortex on the platform and possibly, but not necessarily, on the dorsal surface; a secondary flake retains some cortex on the dorsal surface only; and a tertiary flake retains no cortex. Modification is described with the third word in the technological description as with cores, and is similarly coded either as RETOUCHED, UTILIZED, or UNMODIFIED.

Trim flakes, representing the former retouched edge of a tool, were coded as bifacial or unifacial, if it was discernable whether the original tool edge was bifacially or unifacially worked; they were otherwise coded as TRIM FLAKE.

All broken flakes were size graded according to their surface area, and coded with a number ranging from one to five that correspond with five areas that range in size

from 10 mm^2 to 30 mm^2 in 5 mm^2 increments. Any flake larger than 30 mm^2 was assigned the code "6."

In an effort to correlate the relative size of cortex, primary, secondary, and tertiary flakes, since criteria other than size were used in their classification, a cross-tabulation of FLAKE FRAGMENT SIZE GRADE by REDUCTION LEVEL was computed using all broken flakes from the eight sites. Broken flakes were chosen as they represent the majority of flakes in the data set. Generally, cortex flakes were larger than 30 mm^2; primary flakes were 20 mm^2 or larger w with most ranging between 20 mm^2 and 30 mm^2; secondary flakes ranged from 10 mm^2 to over 30 mm^2, most were larger than 20 mm^2; and tertiary flakes extended the entire range, although the distribution is skewed somewhat to the smaller sizes.

Tool categories (MORPHOLOGICAL CLASS) include biface, uniface, burin, graver, drill, knife, axe, adze, cleaver, chopper, scraper, blank, preform, and hammerstone. Because purposeful reduction was one criterion used to define tools, and no functional analysis was undertaken, the presence of specialized knives was undetected. Microscopic edge wear analysis might reveal this functional category.

Both complete and incomplete bifaces were described morphologically. General bifaces are those that are amorphous in shape. Biface fragments are described in both the ARTIFACT CONDITION category and the MORPHOLOGICAL CLASS category.

Three attributes of scrapers were described: whether they are bifacially or unifacially flaked (BI or UN), the location of the retouch (oriented using the bulb of percussion if present to designate the proximal end, and if absent, orienting the artifact so that the distal and proximal ends are those sides adjacent to the sides of greater length). The shape of the retouched edge is also noted, using the adjectives concave (CONC), convex (CONV), straight (STRAI), irregular (IRREG), spokeshave (SPOK), and notch (NOTCH).

A distinction was made between retouched flakes and flake scrapers based on the extent of edge reduction. Generally, flakes which had only a few flake scars on the edges were considered as retouched flakes, and not as scrapers.

Maximum lengths, widths, and thicknesses of all intact flakes and complete tools were measured with calipers to the nearest tenth of a millimeter. A goniometer was used to measure tool edges showing evidence of modification, as well as the reduced edge of retouched flakes.

Terminology was adopted to describe the breakage of any flake or tool, coded under the ARTIFACT CONDITION category. For flakes, BROK PROX indicates the proximal end of the flake remains; BROK DIST that the distal end remains; BROK MED, that the medial portion remains; and BROK refers to an unclassifiable break. INTACT is coded under ARTIFACT CONDITION if the flake was unbroken. Tool breakage terminology is similar to that for flakes. PROX-END is recorded for a remaining distal segment, MEDIAL for a medial segment, LATERAL for a lateral margin, LONGSEG for a lateral segment retaining portions of the distal and proximal ends, TRANSEG for a transverse break where the artifact fragment cannot be determined absolutely to be the proximal or distal portion, PARTIAL if the outline of the tool, if it were complete, is easily reconstructed, and INCOMPLETE if a tool is broken and all other terms are inappropriate to describe the condition of the artifact. COMPLETE is coded for ARTIFACT CONDITION if the tool is unbroken.

Using the descriptive system outlined above, the lithics recovered from each site in the sample will be described and discussed. The data for the materials from each site are summarized in Table 1. Descriptive and metric data for the tools of each examined may be found in the appendix.

The Site Collections

23HE116

Site 23HE116 covers an area of approximately 20,000 square meters and is located on an alluvial terrace between Dumpling Creek and Sparrow Foot Creek, both tributaries of the South Grand River (Fig. 6). The site lies about 150 meters from each creek and 300 meters northwest of their confluence. The Pennsylvanian rock system dominates in this area. Cherokee Prairie soils of the Hepler-Radley-Verdigris-Osage soil association are predominant (Allgood and Persinger 1979).

Site conditions were favorable at the time of collection; the surveyor reports a ground cover of 10-50% in a cultivated field.

The 23HE116 collection contains 420 artifacts. Seventy-three percent (308) of the lithic materials collected were classified as debris, when defining debris as all unmodified pieces of shatter, chunks, raw material and broken and intact flakes. Of these, 71% are flakes.

Eighty-nine percent (194) of the unmodified flakes identified are of Burlington chert; the remaining 24

TABLE 1

Summary of Unmodified Debris, Modified Debris, and Tools
from the Sample of Eight Late Archaic Sites

	HE116		HE238		HE449		BE183		BE312		BE315		BE445		BE448	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
TOTAL NO. ARTIFACTS IN THE COLLECTION	420	100	235	100	329	100	223	100	133	100	251	100	304	100	108	100
UNMODIFIED DEBRIS (% of total)	308	73	204	87	249	76	134	60	94	71	179	71	230	76	86	80
UNMODIFIED FLAKES (% of unmod debris)	218	71	112	55	173	69	63	47	72	77	115	64	162	70	64	74
Tertiary Falkes (% of unmod flakes)	183	84	101	90	151	87	38	61	57	79	96	83	131	81	51	80
Secondary Flakes (% of unmod flakes)	20	9	7	6	19	11	21	34	10	14	16	14	28	17	10	16
Primary Flakes (% of unmod flakes)	15	7	2	2	5	3	3	5	4	6	3	3	3	2	3	5
Cortex Flakes (% of unmod flakes)	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
UMMODIF SHATTER (% of unmod debris)	77	25	90	44	73	29	66	49	21	22	58	32	62	27	21	24
OTHER UNMOD DEBRIS (% of unmod debris)	13	2	2	1	3	1	5	4	1	1	6	3	6	3	1	1
MODIFIED DEBRIS (% of total)	69	16	9	4	39	12	70	31	11	12	22	9	35	12	7	6
MODIFIED FLAKES (% of modif debris)	51	74	5	56	28	72	62	89	9	82	16	73	28	80	7	100
Tertiary Flakes (% of modif flakes)	44	86	3	60	25	89	55	89	6	67	13	81	17	61	4	57
Secondary Flakes (% of modif flakes)	4	8	0	0	3	11	7	11	2	22	0	0	9	32	3	43
Primary Flakes (% of modif flakes)	3	6	2	40	0	0	0	0	1	11	3	19	1	4	0	0
Cortex Flakes (% of modif flakes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MODIFIED SHATTER (% of modif debris)	11	16	4	44	10	26	7	10	0	0	4	18	5	14	0	0
MODIFIED CORES (% of modif debris)	7	10	0	0	1	3	1	1	2	18	2	9	2	6	0	0
UNMODIFIED CORES (% of total)	7	2	11	5	11	3	7	3	3	2	24	10	7	2	2	2
BLANKS AND PREFORMS (% of total)	2	5	0	0	0	0	0	0	2	2	0	0	0	0	0	0
WELL MADE TOOLS (% of total)	41	10	16	7	42	13	19	9	24	18	35	14	41	13	14	13

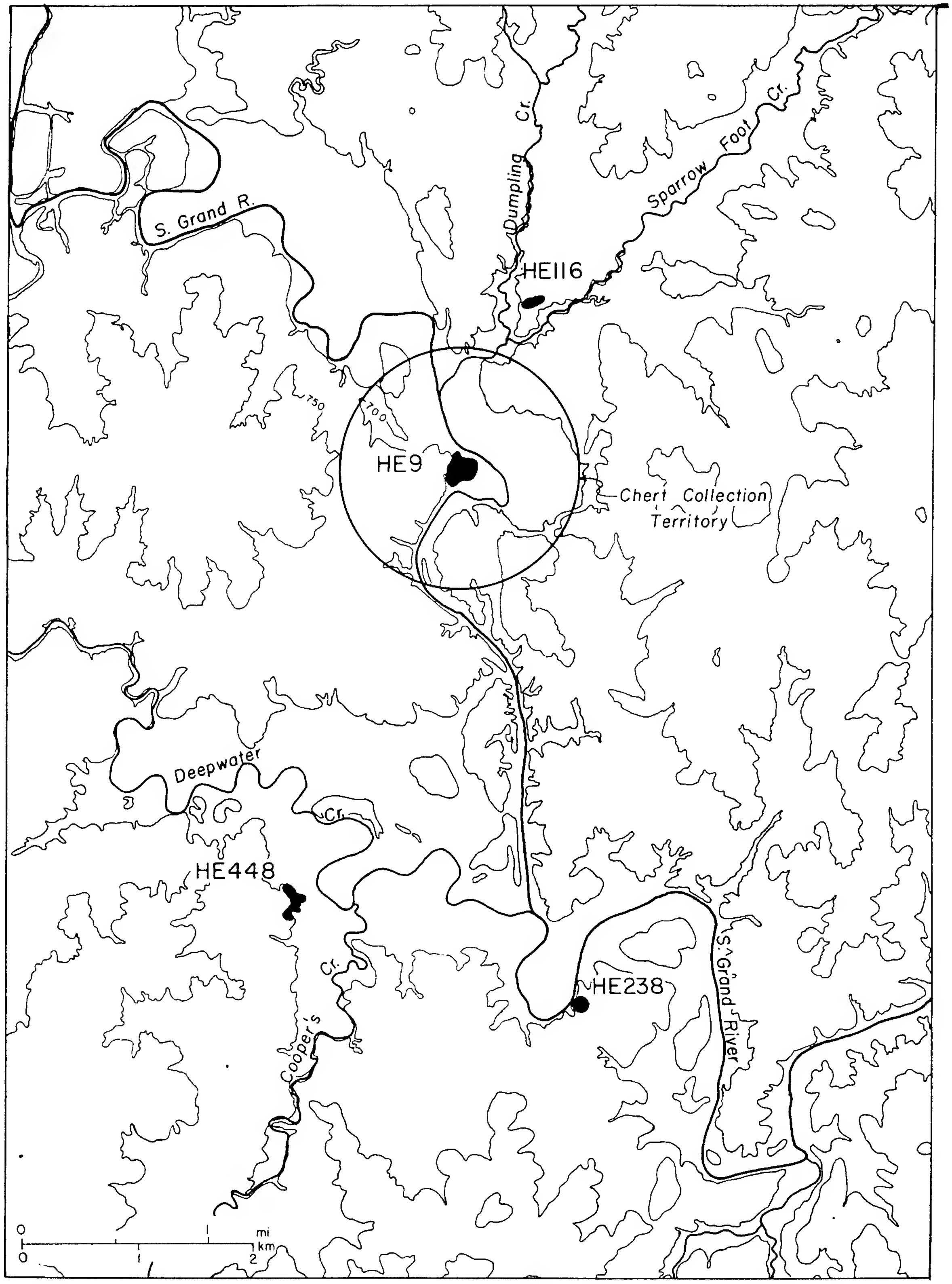

Figure 6. The locations of 23HE116, 23HE238, 23HE448 and chert collection territory HE9.

flakes are of chert types identified as Jefferson City or Chouteau. The classification of the unmodified flakes for the level of reduction revealed the majority (183 or 84%) to be tertiary flakes. Fifteen (7%) are primary flakes and 20 (9%) are secondary flakes. No cortex flakes are in the 23HE116 collection.

The remaining materials classified as lithic debris consist of seven chunks, 77 pieces of shatter and six specimens classified as potential raw material.

The collection from 23HE116 contains 69 specimens (16% of the total) considered here as modified lithic debris. These include all flakes, shatter, and cores modified either by purposeful retouch or by utilization. Eighty-four percent of the modified debris of of Burlington chert; the remainder are of Jefferson City chert.

Flakes comprise 74% (51) of the modified debris. Of these, three are primary flakes, four are secondary flakes, and 43 are tertiary flakes. One tertiary trim flake has been modified. Of the remaining 18 specimens (26%) of modified debris identified in the collection, 11 pieces (16%) are shatter, and seven (10%) are randomly flaked cores.

Unmodified cores in the collection are all randomly flaked. The seven cores exhibiting no modification are of Burlington chert. Two blanks are present, both also of Burlington chert.

The well-made-tool inventory of 23HE116 contains artifacts indicative of diverse activities. Two Sedalia Diggers (Plate 2c, d) were recovered. One is made from an undetermined Mississippian chert; the other is clearly of Burlington chert. A Clear Fork Gouge, originally coded as a scraper based on morphological attributes, made of Burlington chert (Plate 2 g) is included in the collection. A chipped stone axe of ground hematite (Plate 2 $f-f^1$) and one chert cleaver were recovered as well as two gravers, one of Jefferson City chert and one of Burlington chert.

Thirty scrapers were identified; all were unifacially reduced. Twelve of these are end scrapers; all but two, which are made from shatter, were manufactured from flakes. Three of the end scrapers are made from primary flakes, two from secondary flakes and five from tertiary flakes. Of the side scrapers, the shape of the retouched edge is variable; three are straight, one is concave, two are notched, and the remaining six are irregularly shaped.

Fifteen side scrapers were identified; two are manufactured from shatter, two from secondary flakes, 10 from

tertiary flakes (one of which is a trim flake) and one from a randomly flaked core. Three general scrapers were recovered, when defined by edge reduction on adjacent sides; one is unidentifiable to the stage of reduction, the other two are made from tertiary flakes.

Six biface fragments and two projectile point fragments were recovered. Of the biface fragments, four are made of Burlington chert and two are made of Jefferson City chert. One projectile point, identified as a Smith Basal Notched, is made of an unidentifiable Ordovician chert; the other which is unclassifiable as to type is made of Burlington chert.

Recorded in the survey notes for 23HE116 are comments on and drawings of the landowner's collection from the site. The surveyor examined contracting-stem projectile point forms, medium and large sized corner-notched points and Sedalia-like lanceolate forms. A full grooved axe of buff colored diorite was also included.

Only 40 (10%) of the lithic specimens in the surface collection of 23HE116 fall into the category of well-made tools. The remaining 90% of the specimens consist of lithic materials resulting from various stages in the reduction process, including discarded debris, modified debris (18% of the total debris identified) and lithics at intermediary stages of the tool making process (i.e., blanks).

The tools present at 23HE116 seem to represent a surface expression of the Sedalia complex. Tools at 23HE116 thought to be indicative of the Sedalia complex as described by Chapman (1975: 201-203) include the Smith Basal-Notched projectile point, the Clear Fork Gouge, the hematite axe, and the Sedalia Diggers, as well as those tools described in the landowner's collection.

23HE238

Site 23HE238 is located on a footslope exposed west, 20 meters southeast of the South Grand River (Fig. 6). The areal extent of the site is approximately 450 square meters. Pennsylvanian rock systems and Cherokee Prairie soils of the Haig-Hartwell-Deepwater association (Allgood and Persinger 1979) are dominant.

The site is bisected by a farm road and was found in a plowed field, extending into an adjacent wooded area. The site was collected under ground cover conditions of 0-10%; the collection strategy is described as "uncontrolled."

The collection from 23HE238 contains 235 specimens. Of these, 87% (204) are classified as unmodified debris.

One hundred twelve pieces (55% of the unmodified debris) are flakes. Eighty-two percent (92) of the flakes are of Burlington chert, 9% (10) are of Jefferson City chert, 4% (5) are of Chouteau chert, and 4% (4) are of Warsaw chert. One flake is too small to discern chert type.

The classification of the level of reduction of the unmodified flakes at 23HE238 revealed 90% (101) to be tertiary flakes. No trim flakes were identified. Only seven (6% of the unmodified flakes) are secondary flakes and only two (2%) are primary flakes. No cortex flakes were recovered.

Ninety pieces (44% of the total unmodified debris) are shatter. Of these, 95% (86) are of Burlington chert. Three pieces of shatter are of Chouteau chert, and one piece is of Jefferson City chert. The remaining unmodified debris consists of one piece of raw material and one chunk.

Modification, by retouch or by utilization, of lithic debris is exhibited in only nine artifacts (4% of the total collection). Two primary flakes and two tertiary flakes of Burlington chert are modified. One tertiary flake of Chouteau chert has been modified. Four pieces of shatter, two each of Burlington and Chouteau cherts, were modified.

Eleven unmodified cores were recovered from 23HE238. All, with the exception of one cortex core, were reduced by random flaking. Only one core is of Chouteau chert; ten are of Burlington chert. A core from 23HE238 is shown on Plate 3, i.

The well-made tools at 23HE238 constitute 7% (16 tools) of the collection. Seven scrapers were identified; two are end scrapers, three are side scrapers, and two are general scrapers. The end scrapers are manufactured from shatter and the shape of the retouched edge is straight. Two of the side scrapers are made on flakes; one is made on a randomly flaked core. All scrapers are manufactured from Burlington chert.

Two cleavers, eight biface fragments and one broken projectile point complete the tool inventory of 23HE238.

Both cleavers are complete; one is made of Burlington chert; the other of Jefferson City chert (Plate 3, j-k). Five of the eight biface fragments are of Burlington chert; the remaining three are of Jefferson City chert.

The projectile point fragment is classified as a Stone Square Stemmed (Plate 3 h). The chert has been identified as Jefferson City.

The collection from 23HE238 has a high debris content. Modification of flakes and shatter after removal is infrequent. The only diagnostic artifact recovered is the Stone Square Stemmed projectile point fragment which is generally believed to be indicative of a Late Archaic occupation.

23HE448

Site 23HE448 is located on a midslope 180 meters southwest of Deepwater Creek. The approximate surface area is 25,000 square meters. Pennsylvanian rock formations are dominant; Cherokee Prairie soils of the Haig-Hartwell-Deepwater association have developed in this area (Allgood and Persinger 1979). The site was in pasture at the time of collection in 1976; the ground cover is listed as 90-100%.

Three hundred twenty-nine artifacts were recovered from 23HE448. Seventy-six percent (249) are classified as unmodified debris. Sixty-nine percent (173) of the pieces of unmodified debris are flakes. Of the flakes, 64% are of Burlington chert, 18% are of Jefferson City chert, and 16% are of Chouteau chert. Two percent are too small to discern chert type. No cortex flakes were recovered from 23HE448; only five primary flakes (3% of the total number of unmodified flakes) and 19 secondary flakes (11%) are present in the collection. The largest percentage of flakes falls into the reduction level category of tertiary flakes; 151 flakes, or 87%, are tertiary flakes. Three of these are bifacial trim flakes.

Seventy-three pieces of shatter (29% of the total unmodified debris recovered) were identified. Seventy-seven percent of the shatter is of Burlington chert, 16% is of Jefferson City chert, and five percent is of Chouteau chert. One piece of shatter is too small to determine chert type. Two pieces of chert classified as potential raw material and one chert chunk are also included with the unmodified lithic debris.

Modified lithic debris comprises 12% of the lithics collected from the site. Of the 39 pieces of modified debris, 59% are of Burlington chert, 26% are of Jefferson City chert, and 15% are of Chouteau chert. Twenty-eight of the specimens classified as modified debris are flakes (72% of the total modified debris). Of these, three are secondary flakes and the remaining 25 are tertiary flakes. Ten pieces of shatter are modified, as well as one randomly flaked core.

Eleven unmodified cores are in the collection from 23HE448. All have been reduced by random flaking. Eight of these are of Burlington chert, two are of Jefferson City chert and one is of Chouteau chert.

Forty-two well-made tools were identified. Twenty of these are scrapers. Three are shown on Plate 1 g-i. One scraper is manufactured from shatter; all others, with the exception of two which could not be identified as to their technological origin, are made on flakes. All twenty scrapers have been unifacially reduced. Three are end scrapers, 14 are side scrapers and three are general scrapers. The end scrapers are all made on tertiary flakes, and the shape of the retouched edge is variable; one is a spokeshave scraper, one has an irregularly shaped edge, and the other has a convex edge. The side scrapers have been manufactured from primary, secondary, and tertiary flakes. Four have a straight-shaped retouched edge, six are concave, two are irregular, one is convex, and one is a spokeshave scraper. All three general scrapers are made on tertiary flakes. Burlington chert was used for manufacture of 13 scrapers, Jefferson City chert for four, and Chouteau chert for the other two.

Bifaces and biface fragments are fairly numerous at 23HE448. Two complete bifaces are retouched; one is ovate in shape and one may best be described as amorphous in shape. The ovate biface is manufactured from Chouteau chert and the amorphous shaped biface is made of Burlington chert.

Seventeen biface fragments are present. Six of these are made from Burlington chert, eight from Jefferson City and three from Chouteau.

Other tools include the medial portion of a drill manufactured from Jefferson City chert, a graver made on a tertiary flake of Burlington chert, and a cleaver, also of Burlington chert.

Three projectile point fragments were recovered; only one is a basal portion. It is classified as a Sedalia point (Plate 1 j). The chert type of the Sedalia point could only be identified to a Mississippian age formation. The other unidentifiable projectile point fragments are made of chert from Ordovician formations; one is Jefferson City chert.

Lithic debris represents most of the lithic materials recovered from 23HE448. Modification for utilization of flakes and shatter is a significant part of the lithic aggregate. The flake scraper and bifaces are the dominant tool forms at the site. The one identifiable projectile point, the Sedalia point, allows 23HE448 to be assigned to the Late Archaic period.

23BE183

Site 23BE183 extends approximately 5250 square meters on an alluvial terrace of the Pomme de Terre River (Fig. 7). Ordovician rock systems dominate; Ozark soils of alluvial origin of the Hartville-Ashton-Cedargap-Nolin association have developed (Allgood and Persinger 1979).

The site was reportedly collected under conditions of good ground visibility. According to field notes, some lithic debris was left behind.

Two hundred twenty-three artifacts were recovered from 23BE183. Sixty percent (134) of the total are classified as unmodified debris. Of these, 63 (47% of the unmodified debris) are flakes. Six flakes (10% of the unmodified flakes) are of Burlington chert, 51 (81%) are of Jefferson City chert, and four (6%) are of Chouteau chert. Two flakes (3%) are too small to discern chert type. Thirty-eight flakes (61% of the flakes) are tertiary flakes, 21 (34%) are secondary flakes, and three (5%) are primary flakes. No cortex flakes are present in the collection.

Sixty-six pieces of unmodified shatter are present, accounting for 49% of the unmodified lithic debris. Eight percent of the shatter is of Burlington chert, 83% is of Jefferson City chert, and 8% is Chouteau chert. One piece of shatter could not be identified as to chert type. Two chunks and three pieces of raw material are included in the category of unmodified lithic debris.

Modified lithic debris accounts for 31% of the total number of lithic materials collected. Seventy pieces of shatter, flakes and cores have been retouched or utilized. Of these, nine (13%) are Burlington chert, 55 (79%) are Jefferson City chert and four (6%) are Chouteau chert. The chert type of two modified flakes could not be determined. Eighty-nine percent of the pieces of modified debris are flakes. Of these 62 flakes, 89% (55) are tertiary flakes, and 11% (7) are secondary flakes. No cortex or primary flakes have been modified. Seven pieces of shatter (10% of the modified debris identified) are included here as well as one randomly flaked core. All modified shatter and the core are of Jefferson City chert.

Seven unmodified cores reduced by random flaking are present at 23BE183. All are of Jefferson City chert.

The dominant tool form at 23BE183 is the flake scraper, accounting for 16 of the 19 tools present. Two typical

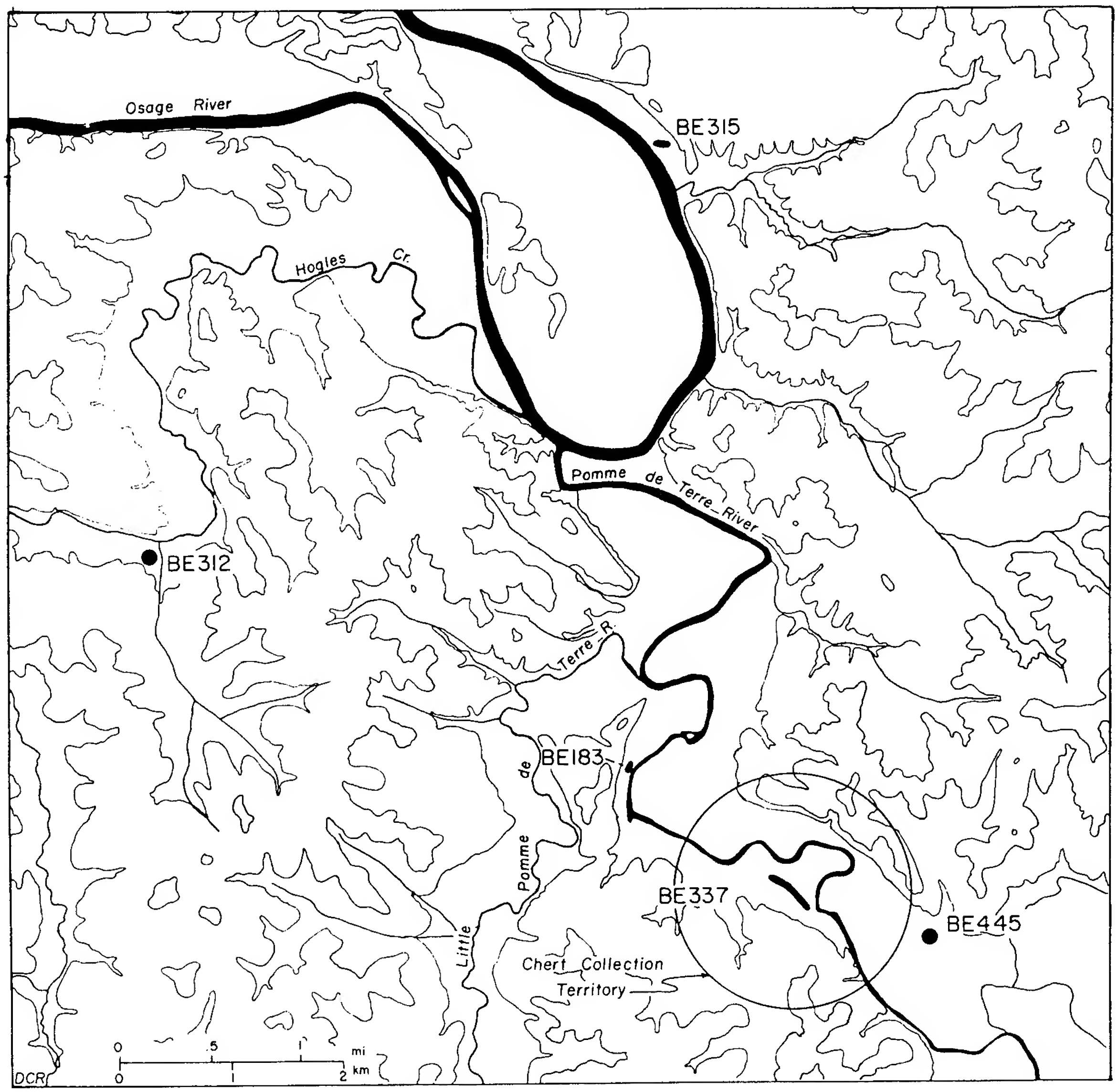

Figure 7. The locations of 23BE183, 23BE312, 23BE315, 23BE445 and chert collection territory BE337.

examples may be seen on Plate 1 b and c. All scrapers from 23BE183 are unifacially retouched. Four of the scrapers are end scrapers. They are manufactured from tertiary and secondary flakes; two are spokeshaves, one has a straight-shaped retouched edge, and one is convex in outline. Nine scrapers have been retouched on the lateral margins of flakes. These are similarly made on tertiary and secondary flakes. Four of these have a concave outline of the retouched edge, three are straight, one is concave and one retouched edge is irregularly shaped. Three general scrapers are also included, made on primary and tertiary flakes. One scraper is made of Burlington chert, 15 are made of Jefferson City chert.

The only other artifacts recovered from 23BE183 are three bifaces of undetermined technological origin. Two of these are projectile points (Plate 1 a, d), one of which is classified as an Etley, and one an unidentifiable lanceolate. The other bifacial tool is an adze (Plate 1 e).

According to the field notes, firecracked rock was observed at 23BE183 but not collected.

The lithics recovered from 23BE183 consist chiefly of debris, although modification of debris seems to have been an important activity at the site with 31% of the materials collected showing evidence of modification after removal from cores. The identification of the one Etley projectile point is the basis for the assignment of 23BE183 to the Late Archaic.

23BE312

Site 23BE312 measures approximately 2000 square meters and is located on an alluvial terrace 40 meters to the south of Hogles Creek (Fig. 7). Ordovician rock systems are dominant; Ozark soils of the Hartville-Ashton-Cedargap-Nolin association are present (Allgood and Persinger 1979).

The site was located in a planted field with good ground visibility. The collection strategy is described in the field notes as unstructured.

One hundred thirty-three artifacts are present in the collection from 23BE312. Ninety-four of these (71%) are classified as unmodified debris. Flakes comprise 77% of the unmodified debris. Of the 72 unmodified flakes present, three (4%) are of Burlington chert, and 67 (93%) are of Jefferson City chert. The chert type of two flakes (3%) could not be determined due to insufficient size. The classification of the unmodified flakes for the level of

reduction revealed 79% (57) to be tertiary flakes, 14% (10) to be secondary flakes, 6% (4) to be primary flakes and 2% (1) to be cortex flakes.

Twenty-one pieces of unmodified shatter were recovered, making up 22% of the unmodified debris. All shatter, with the exception of one which was unidentifiable as to chert, are of Jefferson City chert. One piece of potential raw material completes the inventory of the unmodified debris.

Only nine flakes and two cores showed evidence of modification. Except for one core which is of Chouteau chert, all modified debris is made of Jefferson City chert. Both cores have been randomly flaked. One primary flake, two secondary flakes and six tertiary flakes were modified.

Twenty-four tools were present at 23BE312, accounting for 18% of the total in the collection. Seventeen of these are scrapers. Fourteen of the scrapers are made of Jefferson City chert, two are of Burlington chert and one had an unidentifiable chert type. All scrapers were unifacially reduced; all but one, which was made from shatter, are manufactured from flakes. Six end scrapers are present; the shape of the retouched edge is variable. One is made on shatter, the remaining five are made on tertiary and secondary flakes. The nine side scrapers are made on tertiary, secondary, and primary flakes; again the shape of the retouched edge is variable. Two general scrapers, made on tertiary and secondary flakes, are also included. Two of the scrapers from 23BE312 may be seen on Plate 4 d and e.

Additional artifacts from 23BE312 include a cleaver (Plate 4 f), an adze (Plate 4 b), a chopper, a graver, two biface fragments and an Etley projectile point base (Plate 4 a). The two biface fragments are made of Burlington chert; the remaining tools listed above are all made of Jefferson City chert.

The adze is bifacially worked with wide expanding flake scars extending generally from the lateral margins to the medial axis. Battering is evident on both lateral margins. The general shape is rectangular with one end narrowing and terminating in a rounded, tapered fashion, probably representing the hafted end, although it does not appear to be ground.

The cleaver is modified from a large flake by flake removal from the lateral margins of the ventral surface. The shape is otherwise unmodified. Edge crushing is present on the distal and lateral margins.

The graver is made on a small (less than three centimeters in length and in width) tertiary flake.

Although the majority of the materials recovered from 23BE312 are unmodified debris (71%), a wide diversity of tool forms is also present indicating diversified activities. The Etley projectile point base is indicative of a Late Archaic occupation, an identification that is not inconsistent with the variety of tool forms identified.

23BE315

Site 23BE315 is located on a southwest facing alluvial terrace at the base of Laird Bluff and covers an area of approximately 1000 square meters. It lies 100 meters to the east of the Osage River (see Fig. 7). The site is underlain by rock systems of Ordovician age; predominant soils are Ozark soils of the Hartville-Ashton-Cedargap-Nolin association (Allgood and Persinger 1979).

The site was located in a planted field with good ground visibility. A collection strategy described as "grab" by the surveyor presumably indicates an attempt at obtaining a representative sample of the artifacts present.

Two hundred fifty-one artifacts were recovered from 23BE315. Seventy-one percent (179) of the total number of artifacts collected are classified as unmodified lithic debris. Of these, 115 (65%) are flakes. Ten flakes (6% of all unmodified flakes) are of Burlington chert, 86 (48%) are of Jefferson City chert and four (2%) are made of Chouteau chert. Fifteen flakes (8%) are too small to discern chert type. The largest number of flakes are classified at the level of reduction as tertiary, accounting for 83% (96) of the unmodified flakes present. Fourteen percent are secondary flakes and three percent are primary flakes. No unmodified cortex flakes were recovered from 23BE315.

Shatter comprises 32% of the unmodified lithic debris. Of the 58 pieces of shatter from 23BE315, only four (7%) are Burlington chert, and 49(84%) are Jefferson City chert. Five pieces (9%) are too small to determine chert type. Two chunks and four pieces of potential raw material are present.

Twenty-two specimens are classified as modified lithic debris. Of these, twenty are made of Jefferson City chert; one is of an indeterminate Ordovician chert and one is of Chouteau chert. Three primary flakes, twelve tertiary flakes, and one tertiary trim flakes have been modified. Four pieces of shatter and two randomly flaked cores have been retouched or utilized.

Unmodified cores represent ten percent of the total collection. Of the 24 cores present, 23 are randomly

flaked. One shows evidence of platform preparation prior to flake removal. All unmodified cores recovered from 23BE315 are Jefferson City chert. A randomly flaked core is shown on Plate 4 j.

The well-made tools at 23BE315 constitute 14% of the total number of lithic specimens recovered from the site. Of the 35 tools identified, 30 are scrapers. Five were manufactured from shatter, one was made on a core; the remainder of the scrapers were made on flakes. Seven of the flake scrapers are end scrapers, eight are side scrapers, and eight are general scrapers. The shape of the retouched edge is variable. One scraper was manufactured from Burlington chert; the other 29 were made from Jefferson City chert. Three scrapers are shown on Plate 4 h, k, m.

One hammerstone (Plate 4 l) of Jefferson City chert is present. It is a small, round cobble exhibiting battering and scars from impact.

An axe fragment (Plate 4 i) of Jefferson City chert is also included. It is roughly flaked and broken transversely, expanding in shape where the break occurs. Crushing is present on the lateral edges near the break.

Three biface fragments are present. Only the lateral edges of two of these were recovered. The proximal end of an Afton projectile point form (Plate 4 g) belongs to the 23BE315 aggregate. All are made of Jefferson City chert.

The debris content at 23BE315 is high, with minimal modification. This is consistent with the large number of cores recovered, indicating an ample supply of chert nodules for knapping. Again, the dominant tool form is the scraper. The presence of an Afton projectile point provides the basis for classifying 23BE315 to the Late Archaic period.

23BE445

Site 23BE445 is located on an alluvial terrace on an unnamed intermittent tributary of the Pomme de Terre River (Fig. 7); its areal extent is approximately 580 square meters. Ordovician rock systems and Ozark soils of the Hartville-Ashton-Cedar-Nolin association dominate (Allgood and Persinger 1979).

The pasture in which the site was found presented unfavorable survey conditions at best. Ground cover was reported as 90-100%. Nevertheless, 304 artifacts were recovered.

Seventy-six percent of the materials recovered are classified as unmodified lithic debris. Of the 230 pieces of debris, 162 (70% of all unmodified debris) are flakes. Ten percent of the flakes (17) are Burlington chert, 52% (85) are Jefferson City chert, four percent (6) are Chouteau chert, one percent (2) are Roubidoux chert and 31% (51) are of insufficient size to determine chert type. Eighty-one percent (131 flakes) are tertiary flakes, 17% (28) are secondary flakes and 2% (3) are primary flakes. There are no unmodified cortex flakes.

There are 62 pieces of shatter, accounting for 27% of the unmodified lithic debris. Nine pieces (15% of the shatter present) are of Burlington chert, and 42 pieces (68%) are of Jefferson City chert. Eleven pieces of shatter are too small to discern chert type. Included also in the category of unmodified debris are four chunks and two pieces of potential raw material.

Modified lithic debris comprises 12% of the total number of artifacts collected from 23BE445. Of the 35 specimens of modified debris, four (11%) are of Burlington chert, 29 (83%) are of Jefferson City chert and one (3%) is of Chouteau chert. Chert type could not be identified for one flake. Twenty-eight flakes are modified; 17 are tertiary flakes, nine are secondary flakes and one is a primary flake. Five pieces of shatter and two randomly flaked cores have similarly been modified.

Seven unmodified cores were recovered from 23BE445. Five are randomly flaked, one is a cortex core and one shows evidence of platform preparation prior to flake removal. All but one, which is of Burlington chert, are reduced from Jefferson City chert nodules. A randomly flaked core is shown on Plate 1 m.

Forty-one well-made tools were identified from 23BE445, representing 13% of the total number of artifacts in the collection. Twenty-seven of these are scrapers. Two scrapers have bifacially reduced edges; the remaining 25 have been reduced unifacially. Eight are end scrapers, 11 are side scrapers and eight are general scrapers. Eighteen of the 27 scrapers are made from flakes; nine are tertiary flakes, seven are secondary flakes and two are primary flakes. Seven are made from shatter. Evidence of the technological origin has been obliterated by flaking on two scrapers. Seven scrapers are manufactured from Burlington chert and twenty from Jefferson City chert. Four scrapers from 23BE445 are shown on Plate 1.

Heavy working tools are also present in the 23BE445 aggregate. Recovered were one chipped stone axe (Plate 1 o)

made of Jefferson City chert and one cleaver, also made of Jefferson City chert. Perforating tools in the collection include a drill fragment, a burin, and a graver. Both the graver and the burin have been manufactured from tertiary flakes. The drill is made from Burlington chert and the burin is made from Jefferson City chert. The chert type of the graver could not be determined.

Eight biface fragments and one incomplete Stone Square Stemmed projectile point (Plate 1 k) were recovered. All are of Jefferson City chert.

The Stone Square Stemmed projectile point is the only diagnostic tool recovered from 23BE445, and hence its assignment to the Late Archaic period, although other tool forms present are also indicative of an Archaic period occupation (i.e., the drill fragment). The dominant tool form is the scraper, and utilization of lithic debris appears tc have been a major activity.

23BE448

Site 23BE448 lies on a northwest facing alluvial terrace, 125 meters east of the South Grand River (Fig. 8). Ordovician rock formations and Ozark soils of the Hartville-Ashton-Cedargap-Nolin association (Allgood and Persinger 1979) are dominant. Ground cover approached 100% at the time of the survey, therefore the size of the site was undetermined and the collection may be expected to contain an artifact sample of unknown bias.

One hundred eight artifacts reside in the present collection. Eighty percent (86) are classified as unmodified debris. Flakes comprise 74% of the debris. Fifteen flakes (23% of the total number of unmodified flakes are of Burlington chert, 48 flakes (75%) are of Jefferson City chert, and one flake (2%) is of Chouteau chert. Fifty-one flakes (80%) are tertiary flakes, 10 (16%) are secondary flakes and three (5%) are primary flakes. No cortex flakes are present in the collection.

Lithic material identified as shatter accounts for 24% of the unmodified lithic debris collected from 23BE448. Of these 21 pieces of shatter, 28% (6) are of Burlington chert, 48% (10) are of Jefferson City chert and 23% (5) are of Chouteau chert. One piece of Chouteau chert classified as potential raw material completes the inventory of the unmodified lithic debris from 23BE448.

Only seven flakes recovered from the site exhibit evidence of modification after removal. All are of Jefferson City chert; three are secondary flakes and four are tertiary flakes. These modified flakes represent six percent of the total lithics collected.

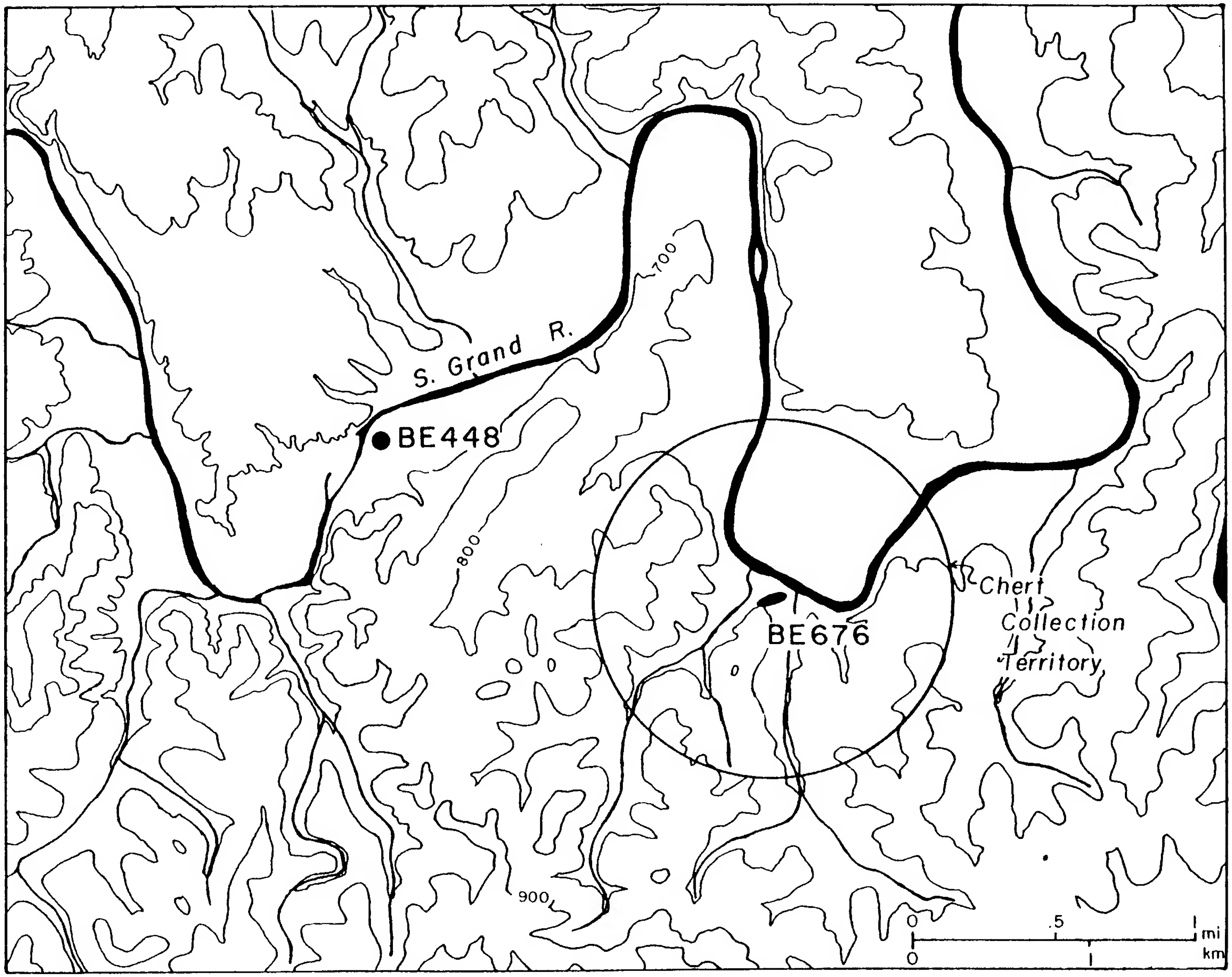

Figure 8. The location of 23BE448 and the chert collection territory BE676.

Two unmodified cores are present in the collection, one a cobble cortex core (Plate 3 g); the other is a randomly flaked core. Both are of Jefferson City chert.

Fourteen tools were identified. Nine of these are flake scrapers. Three of these are end scrapers. The shape of the retouched edge is straight on two of these; the third has a concave shaped working edge. All are made on tertiary flakes.

Four side scrapers are present. The dominant shape of the retouched edge is straight; only one of the side scrapers has an irregularly shaped working edge. The three straight edged side scrapers are made on tertiary flakes, the other is made on a secondary flake. Two scrapers are general scrapers; one is made on a tertiary flake, the other is made on a secondary flake. Three scrapers from 23BE448 are shown on Plate 3 c-e. Of the nine scrapers identified at 23BE448, seven are made of Jefferson City chert, one of Burlington chert and one of Chouteau chert.

Two bifaces were recovered. One is a Stone Square Stemmed projectile point manufactured from Jefferson City chert (Plate 3 a); the other is a large transversely broken biface which has been modified for hafting (Plate 3 b) and manufactured from chert exotic to the reservoir area. A graver made on a tertiary flake of Chouteau chert and a cleaver manufactured from Jefferson City chert complete the tool inventory of 23BE448.

The dominant tool form at 23BE448 is the flake scraper. There is a high debris content and modification of same does not appear to be an important activity. The basis for the inclusion of 23BE448 to the Late Archaic period is the Stone Square Stemmed projectile point, the only diagnostic tool form recovered.

Chert Resources and Utilization

Extensive attention has been given to the chert resources in the Truman Reservoir Project area. Chert resources as they occur in exposed bedrock, residuum and stream deposit gravels were examined in terms of accessibility and quality in an effort to gain an insight into the technology and economy of prehistoric peoples (Ray Vol. II, Part IV, No. 2).

Chert resources in the project area are abundant, derived from Ordovician dolomite and Mississippian limestone. The Ordovician chert identified in the region is of the chert-bearing Jefferson City formation; the Mississippian cherts are found in Burlington and Chouteau formations.

Frequency of chert type was computed for all eight sites in the sample. Burlington and Jefferson City cherts represent 44.6% and 44.8%, respectively, of the cherts used. Chouteau chert occurs in 4.7% of the specimens. Of the remaining 5.9%, 5.4% were unidentifiable because of insufficient size to observe distinguishing characteristics; the remaining 0.5% were cherts from outside of the Truman Reservoir Project area.

Chert type was examined further in terms of proximity to available chert sources by grouping the eight sites into three subgroups as they related to three of nearby "chert territories," established during Ray's 1979 Chert Survey. A chert territory is a circular area with a one kilometer radius in which the chert resources were intensively surveyed (Ray, this vol.).

The first subgroup considered includes the sites 23HE116, 23HE238 and 23HE448. These sites lie near Chert Territory HE9 (Fig. 6). Of a total of 974 chert artifacts in the three sites combined, Burlington chert is predominant, representing 80.2% of the artifacts; Jefferson City chert occurs in 12.1%, and Chouteau chert occurs in 6.1%. The remaining 1.6% of the artifacts could not be identified.

The only chert-bearing formation lying within Chert Territory HE9 is the Mississippian age Burlington limestone. The nearest outcroppings of Jefferson City and Chouteau cherts are 10 kilometers downstream (Ray, this vol.).

Site 23HE116 is located approximately .5 kilometers north of the boundary of the HE9 Chert Territory (Fig. 6). Of a total of 410 artifacts, Burlington chert is represented in 88.7% of the artifacts; Jefferson City chert in 9.3% of the artifacts, and Chouteau chert in 1.5% of the artifacts.

23HE238 is located approximately five kilometers downstream from the HE9 Territory, on the South Grand River (Fig. 6). Of a total of 235 specimens, 85.9% are of Burlington chert, 6.8% are of Jefferson City chert, and 4.2% are of Chouteau chert.

Site 23HE448, located approximately four kilometers from the HE9 Territory, lies near Cooper Creek (Fig. 6), where an outcropping of Chouteau cherts is reported 10 kilometers due southwest of the HE9 Territory (Ray, this vol.). Of the 329 artifacts from 23HE448, the frequencies are as follows: Burlington chert, 65.3%, Jefferson City chert, 1.9% and Chouteau chert, 13.1%.

The significant increase in the use of Jefferson City and Chouteau cherts as site location is nearer resources

other than the Burlington chert-bearing formations present evidence that chert procurement was primarily a localized activity. A crosstabulation of chert type by source was computed to determine the various sources of the cherts. Although most were indeterminable as to source for the lack of cortex, Burlington and Chouteau cherts were procured in stream beds as well as from residual and bedrock sources (Table 2).

The second subgroup consists of sites 23BE183, 23BE312, 23BE315, and 23BE445. These sites lie within seven kilometers of Chert Territory BE337 (Fig. 7). Of the seventeen chert sites recorded in this territory, seven were in roadcuts, a source of chert certainly unavailable to prehistoric populations (Ray, this vol., Pt. 1). The remainder were residual sources. All three chert types occur in the BE337 Territory; however, they occur in variable quantities and qualities, depending on precise location. The variability of Jefferson City chert remained constant throughout the chert territory; the Chouteau chert throughout the territory was reportedly of poor knapping quality; and the Burlington chert was poor in quality in the NE quadrant, although occurring there in large quantities. Poor quality Burlington occurred in the SE quadrant and excellent quality chert is described from the SW quadrant (Ray, this vol.).

The subgroup (23BE183, 23BE312, 23BE315, 23BE445) frequencies for chert type are as follows: Jefferson City chert, 77.0%; Burlington chert, 9.3%; Chouteau chert, 2.9%; and Roubidoux chert (an Ordovician chert-bearing formation located to the east of the reservoir area) occurred in two specimens. The chert type of the remaining 10.6% of the 903 artifacts in this subgroup could not be determined.

Site 23BE445 lies in nearest proximity to BE337, about .25 kilometer east of the periphery of the SE quadrant of the chert territory (Fig. 7). Of the 300 chert specimens in the collection, Jefferson City chert was represented in 61.7%, Burlington in 14.0%, and Chouteau in 2.3%. A preference for Jefferson City chert may be postulated at 23BE445.

Site 23BE183 lies north of Chert Territory BE337 on the west bank of the Pomme de Terre River, less than one kilometer from the edge of the chert territory. Of the 223 artifacts in the collection, 82.5% were of Jefferson City chert, 9.4% were of Burlington chert, and 5.8% were of Chouteau chert. From 23BE183 2.2% of the chert was unidentifiable as to chert type. The bottomlands of the Pomme de Terre were inundated at the time of the Chert Survey; therefore, chert resources in this area could not be

TABLE 2

Crosstabulation of Chert Type by Source for Subgrouping Consisting of Sites HE116, HE238, and HE448

	Source					
Chert	River Cobble	Nodule-Cortex	Indeterminant	Secondary	Cortex	Total
Indet. Mississippian	0	0	1	0	1	2
Indet. Ordovician	0	0	2	0	0	2
Indet. Small	0	0	8	0	0	8
Warsaw	-	-	4	-	-	4
Burlington	46	80	589	29	37	781
Jefferson City	0	11	97	0	10	118
Chouteau	2	6	49	1	1	59
Total	48	97	750	30	49	974

discerned. However, it may again be postulated that a selection for Jefferson City chert was operating at 23BE183.

Site 23BE312 is located about 5.25 kilometers NW of the chert territory and is on Hogles Creek (Fig. 7). Of the 132 artifacts in the collection, again, Jefferson City chert represented the majority, 90.0%. Burlington chert was represented by 5.3%, and Chouteau chert by only 0.8%. The chert type of 3.0% of the artifacts was indeterminable. The actual availability of these cherts along Hogles Creek is not known; however, the Geologic Map of Missouri (Anderson 1979) shows outcrops of Jefferson City formations becoming thicker moving north and northwest from the chert territory.

Site 23BE315 is located almost six kilometers due north of the chert territory on the Osage River (Fig. 7). Of the 248 specimens, Jefferson City chert occurs in 83.5% of the cases, Burlington chert in 5.6% of the cases, and Chouteau chert in 2.0% of the cases. Of the chert artifacts, 8.9% were indeterminable. Again, the thicker outcroppings of the Jefferson City chert north of Chert Territory BE337 may account for its heavy utilization.

A crosstabulation was computed for this subgrouping of chert type by source. Although the majority of chert specimens were unidentifiable as to source, few pieces were clearly of stream gravel origin (Table 3).

The third subgroup consists of only one site, 23BE448. The proximity to Chert Territory BE676 provided the basis for this assignment (Fig. 8). Jefferson City chert is the only reported outcrop in the NE quadrant of the chert territory. The other three quadrants contain outcroppings of the Jefferson City, Burlington, and Chouteau chert-bearing formations. The primary source of these cherts is residuum, but all three are available in the stream bed as well. Jefferson City chert outcrops from 660 feet to about 740 feet on the south bank of the South Grand River, Chouteau chert outcrops from about 740 feet to 780 feet and residual Burlington chert is available at elevations from above 775 feet to the tops of the ridges (Ray, this vol., Part IV, No. 2).

The frequency of chert type occurrence of the total number of the 108 specimens from 23BE448 is as follows: 70.3% Jefferson City chert, 20.3% Burlington chert and 8.3% Chouteau chert. One artifact recovered, a broken biface, was made from Foraker chert, a chert type known to occur in parts of eastern Kansas and Oklahoma (Haury 1979: 221).

TABLE 3

Crosstabulation of Chert Type by Source for Subgrouping Consisting of Sites BE445, BE312, BE183, and BE315

	Source					
Chert	River Cobble	Nodule-Cortex	Indeterminant	Secondary	Cortex	Total
Indeterminant	0	2	1	0	1	4
Indet. Ordovician	0	0	1	0	0	1
Indet. Small	1	2	65	0	2	70
Burlington	2	8	50	2	0	62
Jefferson City	7	110	352	14	25	508
Roubidoux	0	2	0	0	0	2
Chouteau	1	2	16	0	2	21
Total	11	126	485	16	30	668

All three chert types are readily available in the local site area of 23BE448. Jefferson City chert may be a preferred chert because of easier procurement and greater knappability.

The crosstabulation for chert type by source for 23BE448 indicates that stream gravel cherts were not greatly utilized (Table 4).

Discussion

The Late Archaic sites examined exhibit common features, other than the initially obvious one of their inclusion of projectile point types assigned to the Late Archaic period in their inventories.

The debris content (defining debris as all unmodified flakes and shatter) is high at all sites, representing at least 53% of the total inventories and accounting for as much as 82% at one site (23HE238).

The percentage of flakes in the lithic aggregates is considerably higher than that of shatter in the eight sites. Flakes alone represent from 50% to 75% of the total number of artifacts present at each site. Cortex and primary flakes are uncommon in the collections. This may be due to the general absence of cortex on the chert sources themselves. It may possibly be reflective of the easy access to chert sources, making it unnecessary to carry larger nodules still retaining cortex back to the site. This is supported by the large numbers of secondary and tertiary flakes found in the aggregates. Because this author had no control over the collection strategy employed at the sites in the sample, however, and the description of the strategies indicates them to be far from systematically controlled, these speculations are offered with caution.

Flake modification in the form of retouch was fairly commonly accomplished in most of the sites in the sample. With the exception of 23HE238, where only 5% of the total number of flakes have been retouched, the percentage of flakes that were retouched subsequent to removal is between 15% and 23%.

The high incidence of randomly flaked cores is common to the eight sites. The near absence of cores with platform preparation may also be a reflection of the availability of local chert sources indicating the lack of importance of maximum efficiency in utilization and reduction of chert nodules.

The tool inventories of all eight sites support their original assignment to the Late Archaic period. Scrapers

TABLE 4

Crosstabulation of Chert Type by Source for BE448

	Source					
Chert	River Cobble	Nodule-Cortex	Indeterminant	Secondary	Cortex	Total
Burlington	0	4	17	0	1	22
Jefferson City	2	15	57	1	1	76
Chouteau	0	2	7	0	0	9
Foraker	0	0	2	0	0	2
Total	2	21	83	1	2	109

are the dominant tool forms in the eight sites, typical of the Archaic in general. Cutting tools, in the form of bifaces, are represented at each site, with the exception of 23BE183 where bifaces other than projectile point forms are absent.

Other tool forms present within the sites which do not appear consistently in each site include hammerstones, adzes, axes, gravers, drills, burins, choppers, Clear Fork Gouges, Sedalia Diggers, blanks, and preforms. Cleavers are present at all sites but 23BE183 and 23BE315 and may be considered a typical member of the Late Archaic assemblage. The absence of tools relating to foraging activities is notably absent at all sites but 23HE116.

Site 23HE116, containing two pieces of rubbed hematite, a chipped hematite axe, a Clear Fork Gouge and two Sedalia Diggers, as well as the Smith Basal-Notched projectile point, indicates a clear similarity to the Sedalia Complex described by Chapman (1975). The full grooved axe, Sedalia Lanceolate, and the corner-notched projectile point forms observed in the landowner's collection support this classification.

Comparison of the lithic aggregates of the other seven sites to other Late Archaic components recognized in Missouri is more difficult. Some generalizations and speculations may be made, however, concerning the activities indicated during this time in the Truman Reservoir area by the presence and/or absence of certain lithic components in the aggregates.

Activity diversification is indicated at these sites by the variety of tool forms present. The presence of hammerstones at two of these sites and the great amounts of lithic debris at all the sites are indicative of chert knapping activities. Scrapers may represent scraping activity and bifaces may represent cutting activity.

The substantial number of retouched and utilized flakes also indicates cutting activities. Chapman (1975: 185) notes a lack of flake tools during the Late Archaic, however, suggesting that flake tools are more commonly associated with a hunting tradition, as opposed to the primary emphasis on plant procurement speculated for this period. The Late Archaic sites in this sample also exhibit a lack of manos and metates, also considered to be aids in food processing. The presence of fire cracked rock noted by the surveyor at 23BE183 may indicate cooking and stone boiling, an activity associated with the Late Archaic.

The lack of plant procurement and processing tools at all sites in the sample, except 23HE116, and the low frequency of well made tools may reflect the nature of the open site occupations during the Late Archaic in the Ozark Highland and Western Prairie regions of Missouri. The Late Archaic occupations of this region may have been temporary compsites utilized for shorter periods of time than would be the case in Chapman's concept of a base camp from which subsistence activities were pursued (Chapman 1975: 127). The lack of these particular tool forms in the eight sites discussed above may be due to their presence in a portable (curated) tool kit which was transported from campsite to campsite.

Chert procurement appears to be a highly localized activity. Prehistoric populations were exploiting those resources nearest them, as is evidenced by the high percentage of immediately local cherts in the lithic inventories. The relative abundance of chert nodules suitable for knapping in Late Archaic times is supported by the large amounts of debris at these sites and by the somewhat haphazard use of cores indicated by the low frequency of cores with prepared platforms. Indeed, the only chert identified in the 2003 artifacts examined from the eight sites that is exotic to the Truman Reservoir area is the biface from 23BE448 manufactured from Foraker chert. This may possibly be accounted for in terms of the idea of portable tool kits and the movement of peoples between temporary campsites.

Conclusion

Although many sites in the sample examined lack a complete inventory of artifacts thought to be diagnostic of the Late Archaic period, the investigation of their composition has presented a basis for the recognition of the character of surface expressions of Late Archaic aggregates in the Truman Reservoir area. Because these eight sites were open sites, as opposed to the shelter and cave sites from which the Late Archaic is best known in Missouri (Chapman 1975; Wood and McMillan 1976), it has been postulated that they may represent more temporary occupations and a more nomadic lifeway than is speculated for the Late Archaic period in this region.

The Late Archaic sites examined share features among themselves and with other Late Archaic components in Missouri, however, adding data to support the model of prehistoric adaptation in the ecotonal region between the Western Prairie and the Ozark Highland.

APPENDIX

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23BE183								
	ADZE	ADZE	NA	COMPLETE	834	392	205	79
	BIFAC PJ	BIFAC	NA	PARTIAL	0	0	0	0
	BIFAC PJ	BIFAC	NA	MEDIAL SEGMENT	0	0	0	0
	SCRP UN E CONV	FLAKE	TERTIARY	COMPLETE	477	274	52	76
	SCRP UN E STRAI	FLAKE	SECONDARY	COMPLETE	450	361	71	72
	SCRP UN E SPOK	FLAKE	TERTIARY	COMPLETE	400	495	138	76
	SCRP UN E SPOK	FLAKE	TERTIARY	COMPLETE	419	429	130	84
	SCRP UN GENERAL	FLAKE	PRIMARY	COMPLETE	331	345	73	83
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	459	515	140	68
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	366	363	70	78
	SCRP UN S STRAI	FLAKE	SECONDARY	COMPLETE	537	424	105	88
	SCRP UN S STRAI	FLAKE	TERTIARY	INTACT	429	410	112	67
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	439	426	71	69
	SCRP UN S CONC	FLAKE	SECONDARY	COMPLETE	468	296	45	76
	SCRP UN S CONC	FLAKE	SECONDARY	COMPLETE	493	286	129	86
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	472	220	114	76
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	384	186	56	74
	SCRP UN S IPREG	FLAKE	TERTIARY	COMPLETE	419	326	64	88
	SCRP UN S CONV	FLAKE	TERTIARY	COMPLETE	370	211	114	75
VALIDN	19	19	16	19	17	17	17	17

* WORK EQUALS WORKING EDGE ANGLE - MEASUREMENTS IN MM

APPENDIX: Continued

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23BE312								
	BIFAC PJ	BIFAC	NA	PROXMAL END	0	0	0	0
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	52
	BIFACE FRAG POINT	BIFAC	NA	DISTAL END	0	0	0	51
	SCRP UN E CONV	SHATTER	MISSING	COMPLETE	483	355	97	70
	SCRP UN E CONV	FLAKE	TERTIARY	COMPLETE	168	0	84	77
	SCRP UN E STRAI	FLAKE	SECONDARY	COMPLETE	281	298	73	70
	SCRP UN E SPOK	FLAKE	TERTIARY	COMPLETE	457	443	90	88
	SCRP UN E IRREG	FLAKE	SECONDARY	COMPLETE	348	500	109	70
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	394	461	86	68
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	528	382	94	75
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	854	711	205	87
	SCRP UN S STRAI	FLAKE	PRIMARY	COMPLETE	297	169	70	73
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	297	189	52	79
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	383	237	54	65
	SCRP UN S CONC	FLAKE	SECONDARY	COMPLETE	317	491	132	72
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	565	264	115	74
	SCRP UN S IRREG	FLAKE	TERTIARY	COMPLETE	333	292	55	79
	SCRP UN S IRREG	FLAKE	TERTIARY	COMPLETE	214	362	54	72
	SCRP UN S CONV	FLAKE	SECONDARY	COMPLETE	560	234	144	72
	SCRP UN S CONV	FLAKE	TERTIARY	COMPLETE	274	314	40	72
	GRAVER	FLAKE	TERTIARY	COMPLETE	294	245	48	0
	CHOPPER	NA	NA	LATERAL EDGE	0	0	0	0
	CLEAVER	NA	NA	COMPLETE	849	788	302	0
	ADZE	NA	NA	COMPLETE	908	372	202	87
VALIDN	24	21	17	24	20	19	20	20

* WORK EQUALS WORKING EDGE ANGLE - MEASUREMENTS IN MM

APPENDIX: Continued

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23BE315								
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	78
	BIFACE FRAG	BIFAC	NA	INCOMPLETE	0	0	0	0
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	0
	SCRP UN E CONV	FLAKE	SECONDARY	COMPLETE	317	510	173	71
	SCRP UN E CONV	FLAKE	TERTIARY	COMPLETE	540	364	180	81
	SCRP UN E STRAI	SHATTER	MISSING	COMPLETE	420	250	111	0
	SCRP UN E STRAI	FLAKE	TERTIARY	COMPLETE	227	327	73	70
	SCRP UN E STRAI	FLAKE	TERTIARY	COMPLETE	224	176	20	72
	SCRP UN E CONC	FLAKE	TERTIARY	COMPLETE	281	360	43	76
	SCRP UN E CONC	FLAKE	TERTIARY	COMPLETE	180	144	38	67
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	231	406	92	81
	SCRP UN GENERAL	SHATTER	MISSING	COMPLETE	578	260	153	78
	SCRP UN GENERAL	SHATTER	MISSING	COMPLETE	588	325	149	84
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	834	444	119	76
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	860	515	208	0
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	485	329	138	67
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	374	336	101	73
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	416	332	107	88
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	649	333	108	88
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	362	249	57	79
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	265	254	60	67
	SCRP UN S STRAI	SHATTER	MISSING	COMPLETE	377	256	88	84
	SCRP UN S STRAI	FLAKE	SECONDARY	COMPLETE	189	236	70	86
	SCRP UN S STRAI	FLAKE	SECONDARY	COMPLETE	262	294	45	71
	SCRP UN S CONC	SHATTER	MISSING	COMPLETE	0	0	0	83
	SCRP UN S CONC	CORE	RANDOM FLAKING	COMPLETE	544	345	167	86
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	517	435	222	82
	SCRP UN S NOTCH	SHATTER	MISSING	COMPLETE	574	364	199	78
	SCRP UN S NOTCH	FLAKE	TERTIARY	COMPLETE	279	222	45	64
	SCRP UN S NOTCH	FLAKE	TERTIARY	COMPLETE	279	221	42	60
	SCRP UN S CONV	SHATTER	MISSING	COMPLETE	650	429	178	79
	SCRP UN S CONV	FLAKE	CORTEX	COMPLETE	391	450	121	78
	HAMMERSTONE	NA	NA	COMPLETE	0	0	0	0
	AXE	NA	NA	TRANSVERSE SEGMENT	0	0	0	0
	SCRP UN S SPOK	FLAKE	TERTIARY	COMPLETE	562	422	151	88
VALIDN	35	33	23	35	29	29	29	29

* WORK EQUALS WORKING EDGE ANGLE - MEASUREMENTS IN MM

APPENDIX: Continued

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23BE445								
	BIFAC PJ	BIFAC	NA	PARTIAL	0	0	0	0
	BIFACE FRAG	BIFAC	NA	INCOMPLETE	0	0	0	0
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	0
	BIFACE FRAG	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	0
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	72
	BIFACE FRAG	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	72
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	63
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	0
	BIFACE FRAG SQU	BIFAC	NA	INCOMPLETE	0	0	0	0
	SCRP UN E CONV	FLAKE	TERTIARY	COMPLETE	235	176	85	80
	SCRP UN E CONV	FLAKE	TERTIARY	COMPLETE	367	190	55	81
	SCRP UN E STRAI	FLAKE	PRIMARY	COMPLETE	239	471	162	81
	SCRP UN E STRAI	FLAKE	SECONDARY	COMPLETE	658	400	146	70
	SCRP UN E STRAI	FLAKE	SECONDARY	COMPLETE	286	477	121	70
	SCRP UN E STRAI	FLAKE	TERTIARY	COMPLETE	222	297	48	88
	SCRP UN E CONC	SHATTER	MISSING	COMPLETE	269	189	64	65
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	265	269	60	68
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	495	340	114	0
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	804	929	310	82
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	536	429	95	74
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	336	204	59	62
	SCPP UN GENERAL	FLAKE	TERTIARY	COMPLETE	354	667	249	72
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	410	233	40	63
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	326	313	60	86
	SCRP BI GENERAL	SHATTER	MISSING	COMPLETE	614	382	138	82
	SCRP UN S STRAI	SHATTER	MISSING	COMPLETE	370	304	114	77
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	542	404	112	81
	SCRP UN S STRAI	UNIFAC	NA	COMPLETE	1021	339	215	78
	SCRP UN S IRREG	SHATTER	MISSING	COMPLETE	485	356	129	78
	SCRP UN S IRREG	SHATTER	MISSING	COMPLETE	270	190	70	81
	SCRP UN S IRREG	FLAKE	SECONDARY	COMPLETE	358	214	50	61
	SCRP UN S CONV	SHATTER	MISSING	COMPLETE	347	278	198	85
	SCRP UN S CONV	FLAKE	PRIMARY	COMPLETE	722	369	146	83
	SCRP BI S CONV	BIFAC	NA	COMPLETE	499	330	116	78
	BURIN	FLAKE	TERTIARY	COMPLETE	241	150	31	86
	GRAVER	FLAKE	TERTIARY	COMPLETE	158	198	33	71
	DRILL	BIFAC	NA	DISTAL END	0	0	0	0
	CLEAVER	NA	NA	COMPLETE	772	639	275	0
	AXE	NA	NA	COMPLETE	1170	658	435	0
	SCRP UN S SPOK	SHATTER	MISSING	COMPLETE	374	309	112	77
	SCRP UN S SPOK	FLAKE	TERTIARY	COMPLETE	0	0	0	67
VALION	41	39	20	41	30	30	30	31

APPENDIX: Continued

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23BE448								
	BIFAC PJ	BIFAC	NA	PROXMAL END	0	0	0	0
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	0
	BIFACE FRAG ROUND	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	0
	SCRP UN E STRAI	FLAKE	TERTIARY	COMPLETE	215	170	36	77
	SCRP UN E STRAI	FLAKE	TERTIARY	COMPLETE	426	374	60	80
	SCRP UN E CONC	FLAKE	TERTIARY	COMPLETE	429	395	64	68
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	837	552	255	72
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	312	199	73	81
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	207	212	30	75
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	318	456	80	73
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	260	267	44	75
	SCRP UN S IRREG	FLAKE	SECONDARY	COMPLETE	694	400	219	76
	GRAVER	FLAKE	TERTIARY	COMPLETE	237	128	34	26
	CLEAVER	NA	NA	COMPLETE	1035	724	220	79
VALIDN	14	13	10	14	11	11	11	11

* WORK EQUALS WORKING EDGE ANGLE - MEASUREMENTS IN MM

APPENDIX: Continued

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23HE116								
	BIFAC PJ	BIFAC	NA	PROXMAL END	0	0	0	0
	BIFAC PJ	BIFAC	NA	PROXMAL END	0	0	0	0
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	67
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	73
	BIFACE FRAG POINT	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	0
	BIFACE FRAG POINT	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	73
	SEDALIA DIGGER	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	78
	BIFACE FRAG ROUND	BIFAC	NA	INCOMPLETE	0	0	0	0
	SCRP UN E STRAI	SHATTER	MISSING	COMPLETE	489	358	145	73
	SCRP UN E STRAI	FLAKE	PRIMARY	COMPLETE	376	391	210	82
	SCRP UN E STRAI	FLAKE	TERTIARY	COMPLETE	320	303	104	83
	SCRP UN E CONC	FLAKE	SECONDARY	COMPLETE	584	490	150	83
	SCRP UN E NOTCH	SHATTER	MISSING	COMPLETE	554	400	194	77
	SCRP UN E NOTCH	FLAKE	PRIMARY	COMPLETE	398	514	108	80
	SCRP UN E IRREG	FLAKE	PRIMARY	COMPLETE	250	383	134	90
	SCRP UN E IRREG	FLAKE	SECONDARY	COMPLETE	305	314	111	78
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	617	498	120	76
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	187	293	56	72
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	170	181	38	79
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	261	224	46	72
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	601	490	112	63
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	365	508	91	78
	SCRP UN GENERAL	UNIFAC	NA	TRANSVERSE SEGMENT	0	0	0	0
	SCRP UN S STRAI	SHATTER	MISSING	COMPLETE	489	368	163	85
	SCRP UN S STRAI	FLAKE	SECONDARY	COMPLETE	326	384	41	58
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	362	236	45	68
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	536	314	76	74
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	515	324	104	60
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	241	299	58	64
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	305	324	66	63
	SCRP UN S STRAI	FLAKE	TRIM FLAKE	COMPLETE	378	351	57	74
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	220	315	86	64
	SCRP UN S NOTCH	SHATTER	MISSING	COMPLETE	623	451	238	70
	SCRP UN S IRREG	FLAKE	TERTIARY	COMPLETE	399	244	39	69
	SCRP UN S CONV	FLAKE	TERTIARY	COMPLETE	305	228	49	81
	GRAVER	FLAKE	TERTIARY	COMPLETE	164	169	45	80
	GRAVER	FLAKE	TERTIARY	COMPLETE	180	174	36	54
	CLEAVER	NA	NA	COMPLETE	608	798	200	89
	SCRP UN S SPOK	CORE	RANDOM FLAKING	COMPLETE	929	782	311	82
	SCRP UN S SPOK	FLAKE	SECONDARY	COMPLETE	339	284	67	71
	SEDALIA DIGGER	BIFACE	NA	COMPLETE				
	SCRP UN S SPOK	FLAKE	TERTIARY	COMPLETE	424	305	71	71
VAL	42	40	27	41	32	32	32	36

APPENDIX: Continued

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23HE238								
	BIFAC PJ	BIFAC	NA	PARTIAL	0	0	0	0
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	0
	BIFACE FRAG	BIFAC	NA	TPANSVERSE SEGMENT	0	0	0	0
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	56
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	0
	BIFACE FRAG	BIFAC	NA	INCOMPLETE	0	0	0	0
	BIFACE FRAG POINT	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	59
	BIFACE FRAG SQU	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	0
	BIFACE FRAG ROUND	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	63
	SCRP UN E STRAI	SHATTER	MISSING	COMPLETE	662	349	154	71
	SCRP UN E STRAI	SHATTER	MISSING	COMPLETE	460	420	229	69
	SCRP UN GENERAL	SHATTER	MISSING	COMPLETE	522	319	131	78
	SCRP UN GENERAL	FLAKE	SECONDARY	COMPLETE	490	385	128	73
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	194	249	29	55
	SCRP UN S CONC	CORE	RANDOM FLAKING	COMPLETE	0	0	0	61
	SCRP UN S IRREG	FLAKE	SECONDARY	COMPLETE	674	367	234	81
	CLEAVER	NA	NA	COMPLETE	1100	625	231	77
TDH	CLEAVER	NA	NA	COMPLETE	953	610	203	71
VALIDN	18	16	4	18	8	8	8	12

* WORK EQUALS WORKING EDGE ANGLE - MEASUREMENTS IN MM

APPENDIX: Continued

WELL MADE TOOLS AND LITHIC REDUCTION

SITE	CLASS	REDUCTION STAGE	REDUCTION LEVEL	ARTIFACT CONDITION	LENG1	WIDT1	THICK1	WORK*
23HE448								
	BIFAC PJ	BIFAC	NA	INCOMPLETE	0	0	0	0
	BIFAC PJ	BIFAC	NA	PROXMAL END	0	0	0	0
	BIFAC PJ	BIFAC	NA	PROXMAL END	0	0	0	0
	BIFAC GEN	SHATTER	NA	MISSING	0	0	0	0
	BIFAC OVAL	BIFAC	NA	COMPLETE	514	365	152	68
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	43
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	87
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	63
	BIFACE FRAG	BIFAC	NA	INCOMPLETE	0	0	0	0
	BIFACE FRAG	BIFAC	NA	TRANSVERSE SEGMENT	0	0	0	71
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	0
	BIFACE FRAG	BIFAC	NA	INCOMPLETE	0	0	0	66
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	0
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	63
	BIFACE FRAG	BIFAC	NA	LATERAL EDGE	0	0	0	72
	BIFACE FRAG	BIFAC	NA	MEDIAL SEGMENT	0	0	0	0
	BIFACE FRAG SQU	BIFAC	NA	INCOMPLETE	0	0	0	65
	BIFACE FRAG ROUND	FLAKE	TERTIARY	TRANSVERSE SEGMENT	0	0	0	64
	SCRP UN E CONV	FLAKE	TERTIARY	COMPLETE	614	460	193	71
	SCRP UN E SPOK	FLAKE	TERTIARY	COMPLETE	216	245	45	78
	SCRP UN E IRREG	FLAKE	TERTIARY	COMPLETE	305	201	35	70
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	415	264	94	79
	SCRP UN GENERAL	FLAKE	TERTIARY	COMPLETE	382	305	93	76
	SCRP UN GENERAL	UNIFAC	NA	LATERAL EDGE	0	0	0	81
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	312	368	70	71
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	342	217	52	63
	SCRP UN S STRAI	FLAKE	TERTIARY	COMPLETE	259	218	52	82
	SCRP UN S STRAI	UNIFAC	NA	LATERAL EDGE	0	0	0	0
	SCRP UN S CONC	FLAKE	PRIMARY	COMPLETE	204	264	69	74
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	173	260	48	72
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	183	251	35	63
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	256	317	74	78
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	303	324	69	61
	SCRP UN S CONC	FLAKE	TERTIARY	COMPLETE	169	176	33	81
	SCRP UN S IRREG	FLAKE	SECONDARY	COMPLETE	349	478	100	66
	SCRP UN S IRREG	FLAKE	TERTIARY	COMPLETE	264	232	42	79
	SCRP UN S CONV	SHATTER	MISSING	COMPLETE	494	414	131	83
	BURIN	FLAKE	TERTIARY	COMPLETE	254	184	37	64
	GRAVER	FLAKE	TERTIARY	COMPLETE	350	245	54	0
	DRILL	BIFAC	NA	MEDIAL SEGMENT	0	0	0	0
	CLEAVER	BIFAC	NA	COMPLETE	544	364	129	63
	SCRP UN S SPOK	FLAKE	PRIMARY	COMPLETE	508	397	175	95
VALIDN	42	42	20	41	22	22	22	31
TOTAL VALIDN	234	223	137	233	169	168	169	187

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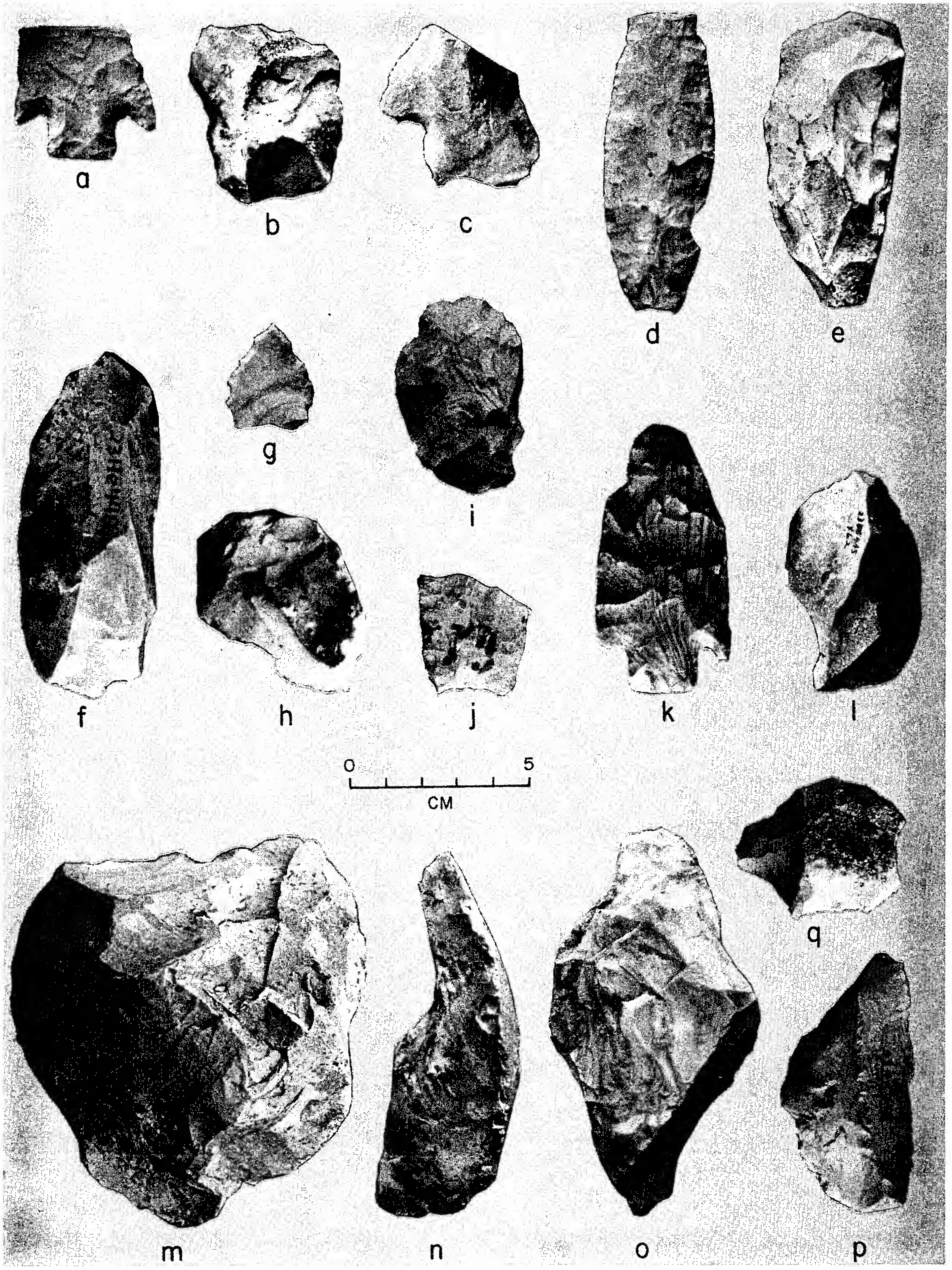

Plate 1. Artifacts from 23BE183: a-Etley point; b-general flake scraper; c-flake spokeshave scraper; d-unclassified lanceolate point; e-bifacially worked adze. 23HE448: f-incompleted biface; g-denticulated flake scraper; h-general flake scraper with side spokeshave; i-general flake scraper; j-basal portion of Sedalia point. 23BE445: k-Stone Square Stemmed point; l-unifacial side scraper; m-randomly flaked core; n-unifacial side scraper; o-chipped stone axe; p-unifacial flake side scraper; q-general flake scraper.

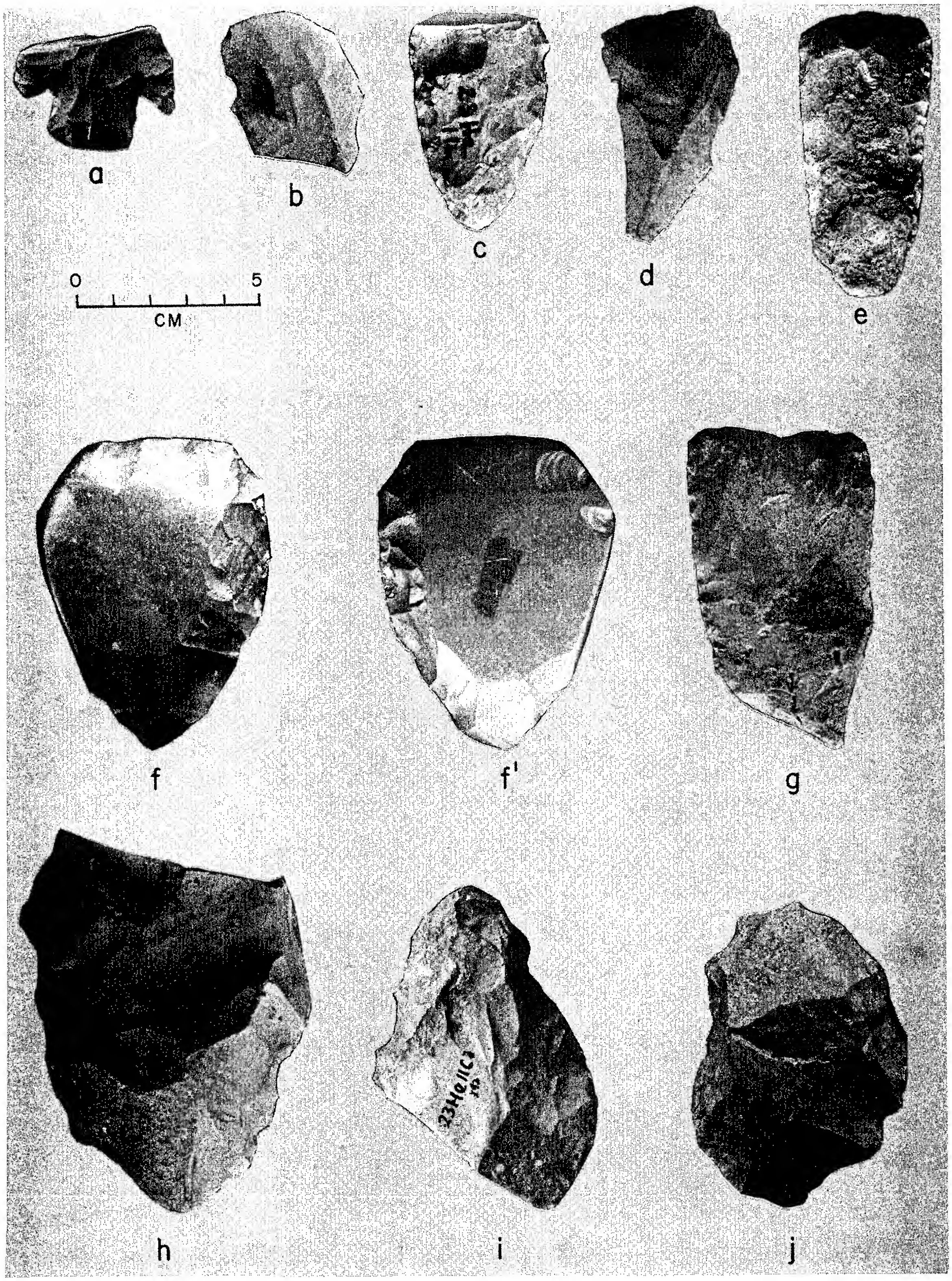

Plate 2. Artifacts from 23HE116 — a, Smith-like point; b, general flake scraper; c, Sedalia Digger; d, flake side scraper; e, Sedalia Digger; f-f', chipped hematite axe, front and back; g, Clear Fork Gouge; h, side scraper; i, broken blank; j, randomly flaked core.

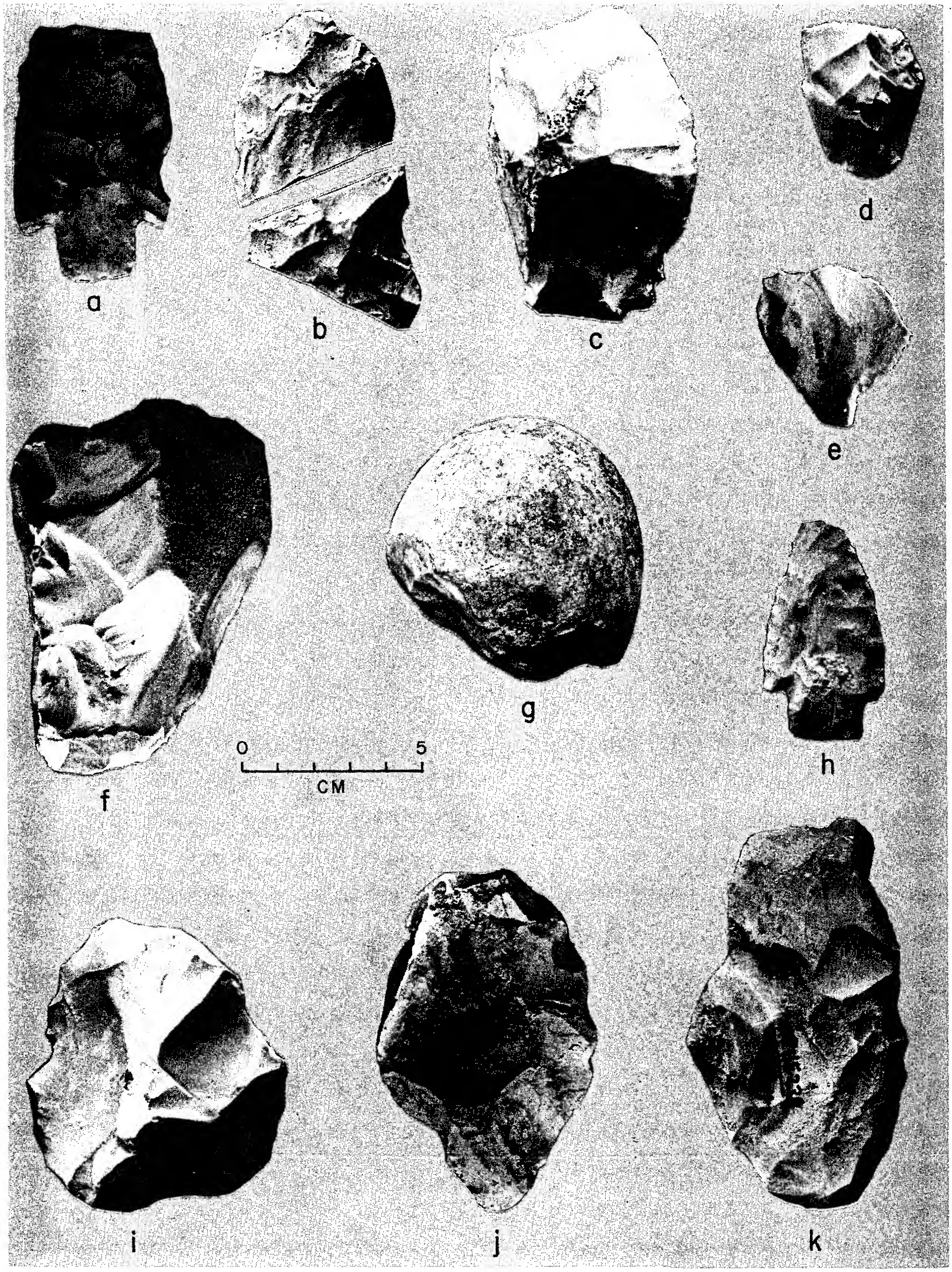

Plate 3. Artifacts from 23BE448 — a, Stone Square Stemmed point; b, broken biface of Foraker chert; c, unifacial scraper; d, flake side scraper; e, flake spokeshave scraper; f, cleaver; g, cobble cortex core. 23HE238: h, Stone Square Stemmed point; i, randomly flaked core; j-k, cleavers.

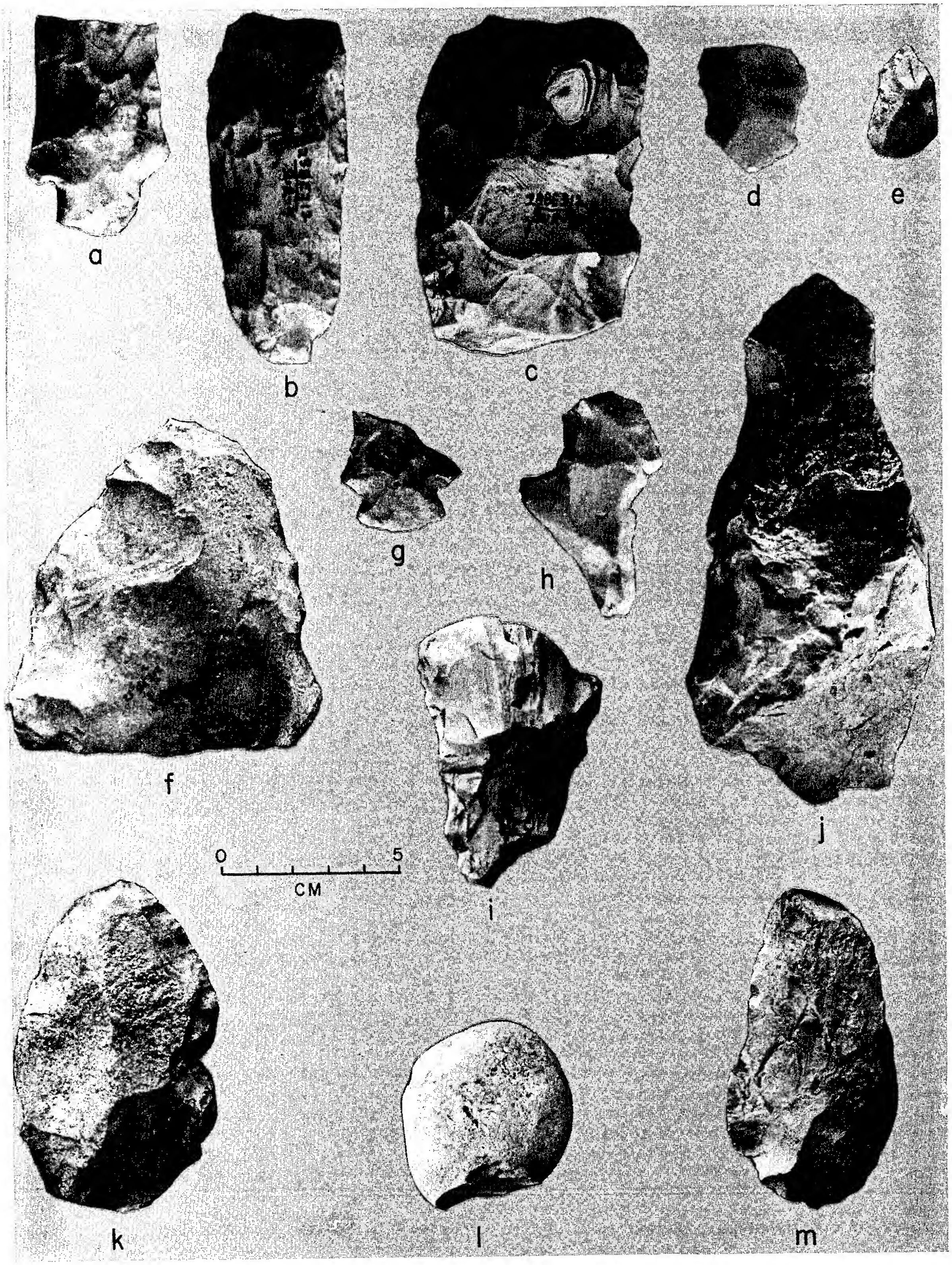

Plate 4. Artifacts from 23BE312 — a, Etley point; b, bifacially worked adze; c, broken preform; d, flake side scraper; e, flake scraper; f, cleaver. 23BE315 — g, Afton point; h, side scraper with side spokeshave; i, axe fragment; j, randomly flaked core; k, general scraper; l, chert hammerstone; m, unifacial flake end scraper.